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Lawrence Livermore National Laboratory

14.4 PFLOPS Simulations of Cloud Cavitation Collapse

1.6 Million Core Particle in-Cell Simulations on Sequoia

National Ignition Facility Laser-Plasma Interaction Simulations

Performance Analysis and Visualization

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LLNL Leads Initiative to Improve Lithium Ion Batteries

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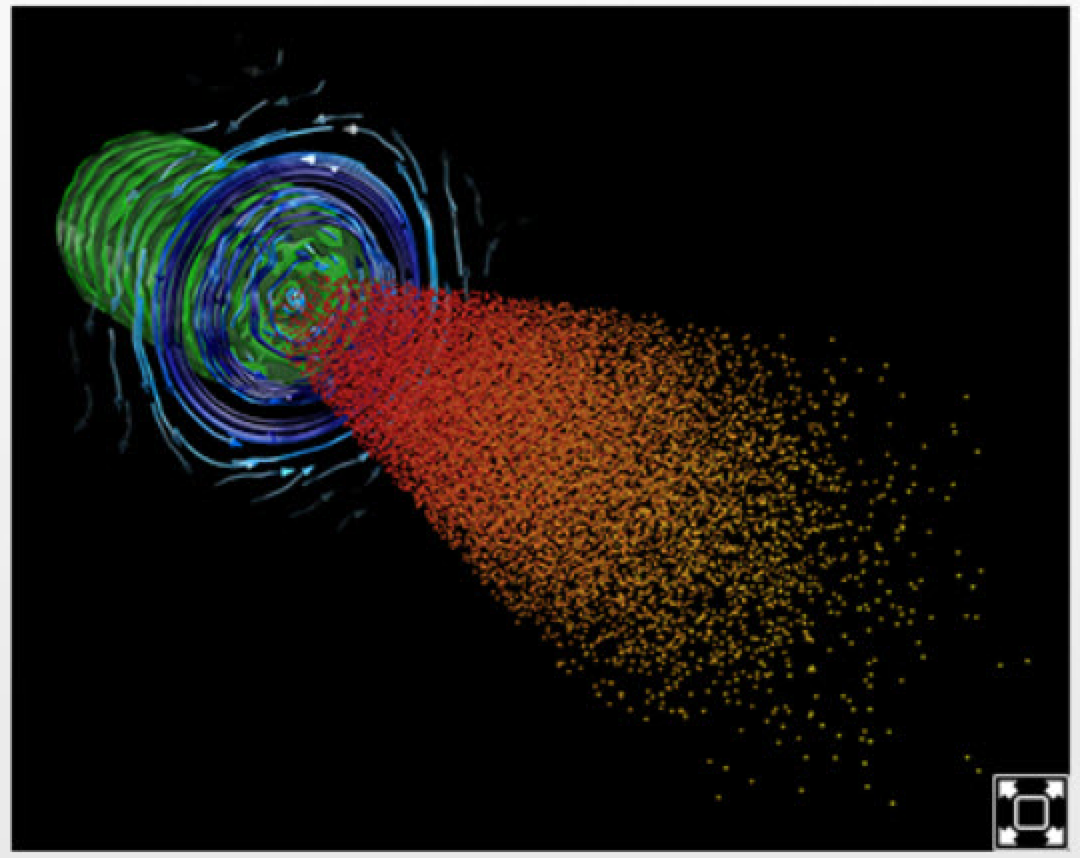
1.6 Million Core Particle in-Cell Simulations on Sequoia

Researchers at Lawrence Livermore National Laboratory performed record simulations using all 1,572,864 cores of Lawrence Livermore National Laboratory's (LLNL) Sequoia supercomputer. The simulations were the largest particle-in-cell (PIC) code simulations by number of cores ever performed. PIC simulations are used extensively in plasma physics to model the motion of the charged particles, and the electromagnetic interactions between them, that make up ionized matter. High performance computers such as Sequoia enable these codes to follow the simultaneous evolution of tens of billions to trillions of individual particles in highly complex systems.

These simulations are used to study the interaction of ultra-powerful lasers with dense plasmas in a proposed method to produce fusion energy, the energy source that powers the sun, in a laboratory setting. The method, known as fast ignition, uses lasers capable of delivering more than a petawatt of power (a million billion watts) in a fraction of a billionth of a second to heat compressed deuterium and tritium (DT) fuel to temperatures exceeding the 50 million degrees Celsius needed to initiate fusion reactions and release net energy. The project is part of the U.S. Department of Energy's Office of Fusion Energy Science Program.

The software used in these simulations was OSIRIS, a PIC code that has been developed through a 10+ year collaboration between the University of California, Los Angeles and Portugal's Instituto Superior Técnico. The OSIRIS code demonstrated excellent scaling in parallel performance to the full 1.6 million cores of Sequoia. By increasing the number of cores for a relatively small problem of fixed size (strong scaling), OSIRIS obtained 75 percent efficiency on the full machine. But when the total problem size was increased (weak scaling), a 97 percent efficiency was achieved.



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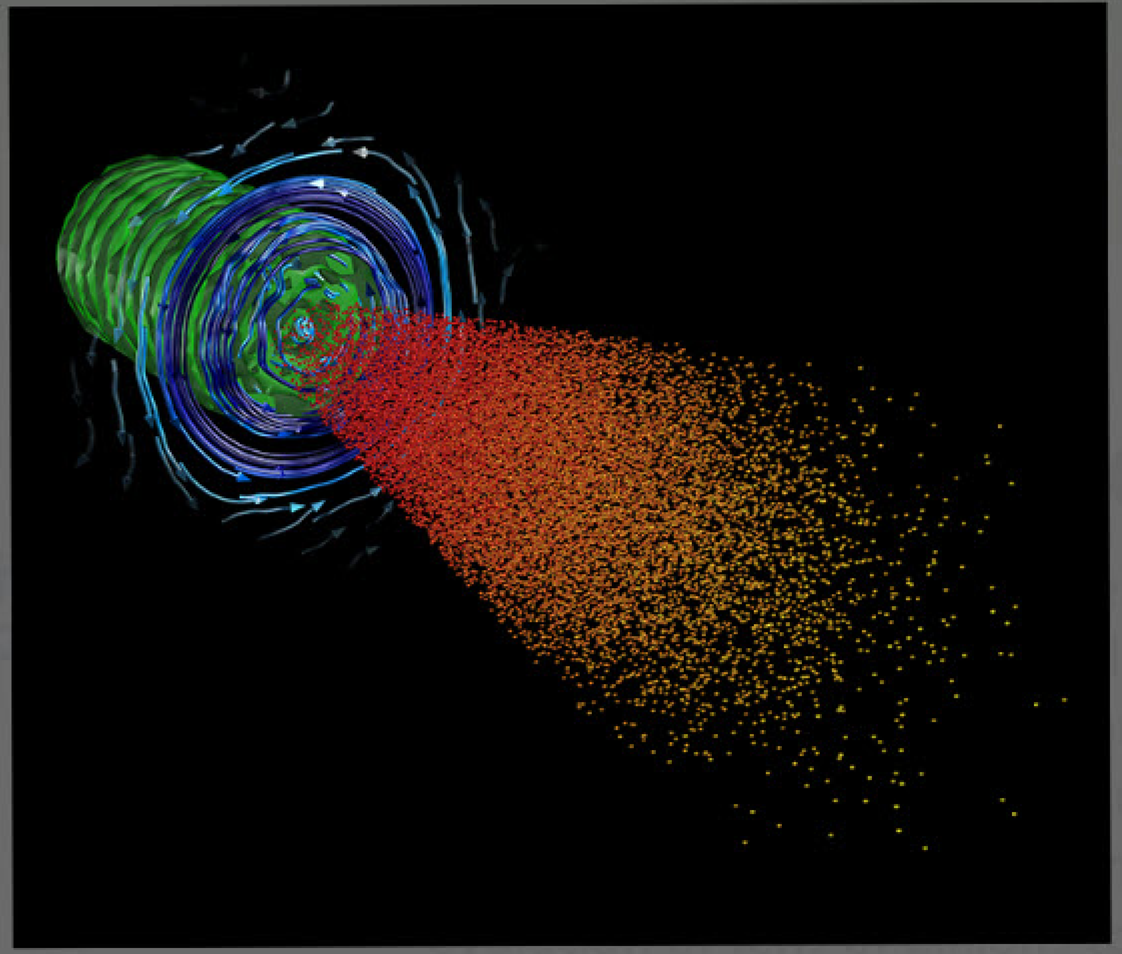

OSIRIS simulation on Sequoia of the interaction of a fast-ignition-scale laser with a dense deuterium-tritium (DT) plasma. The laser field is shown in green, the blue arrows illustrate the magnetic field lines at the plasma interface and the red/yellow spheres are the laser-accelerated electrons that will heat and ignite the fuel.

Lawrence Livermore National Laboratory's 20 petaflop Sequoia IBM Blue Gene/Q system.

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FUNDING AGENCIES: National Nuclear Security Administration (NNSA) Advanced Simulation & Computing (ASC) program. U.S. Department of Energy's Office of Fusion Energy Science Program.

FUNDING ACKNOWLEDGEMENT: Lawrence Livermore National Security, LLC. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DEAC52-07NA27344.

RESEARCHERS: Frederico Fiuza, LLNL; simulation and visualization Warren Mori, UCLA; OSIRIS Ricardo Fonseca, Instituto Superior Técnico, Portugal; visXD, OSIRIS Luis Silva Instituto Superior Técnico, Portugal; OSIRIS RESOURCE: Sequoia, Lawrence Livermore National Laboratory ARCHITECTURE: IBM Blue Gene/Q

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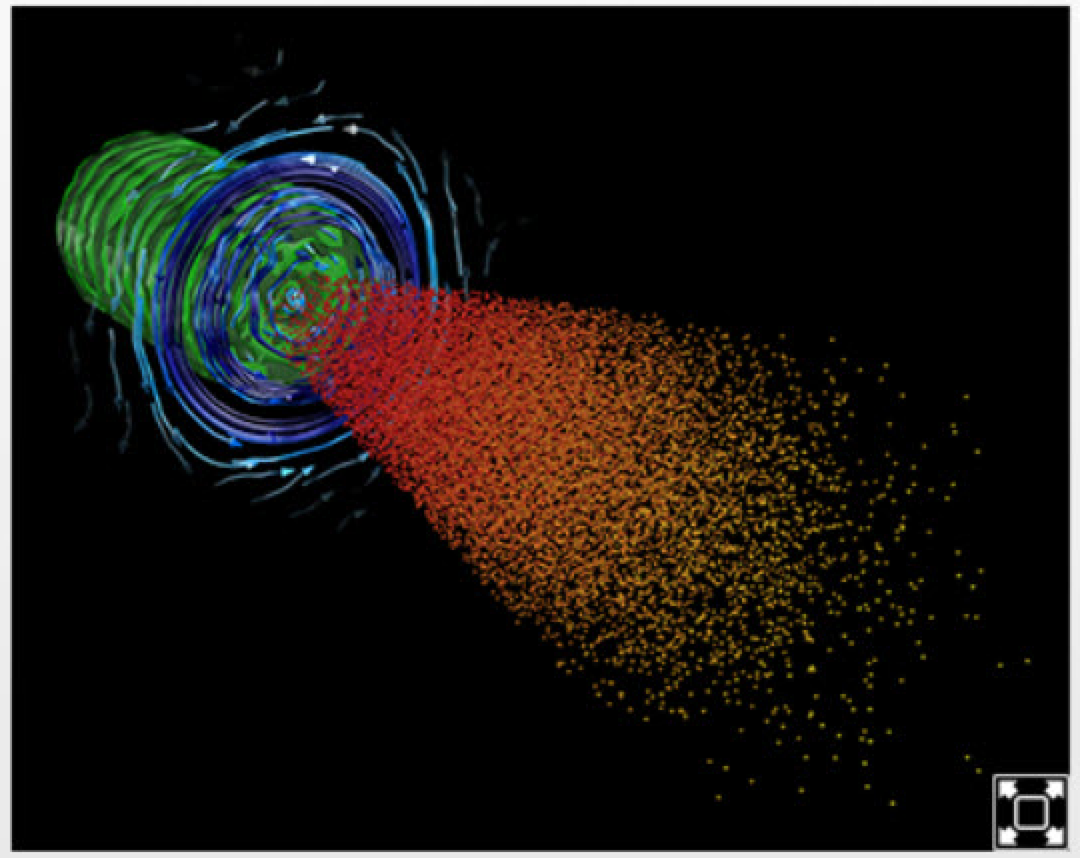
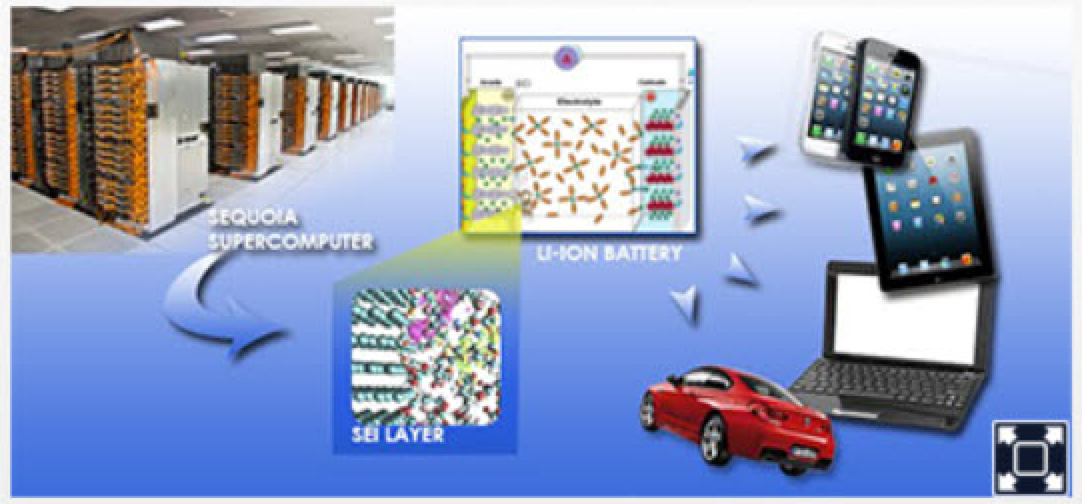
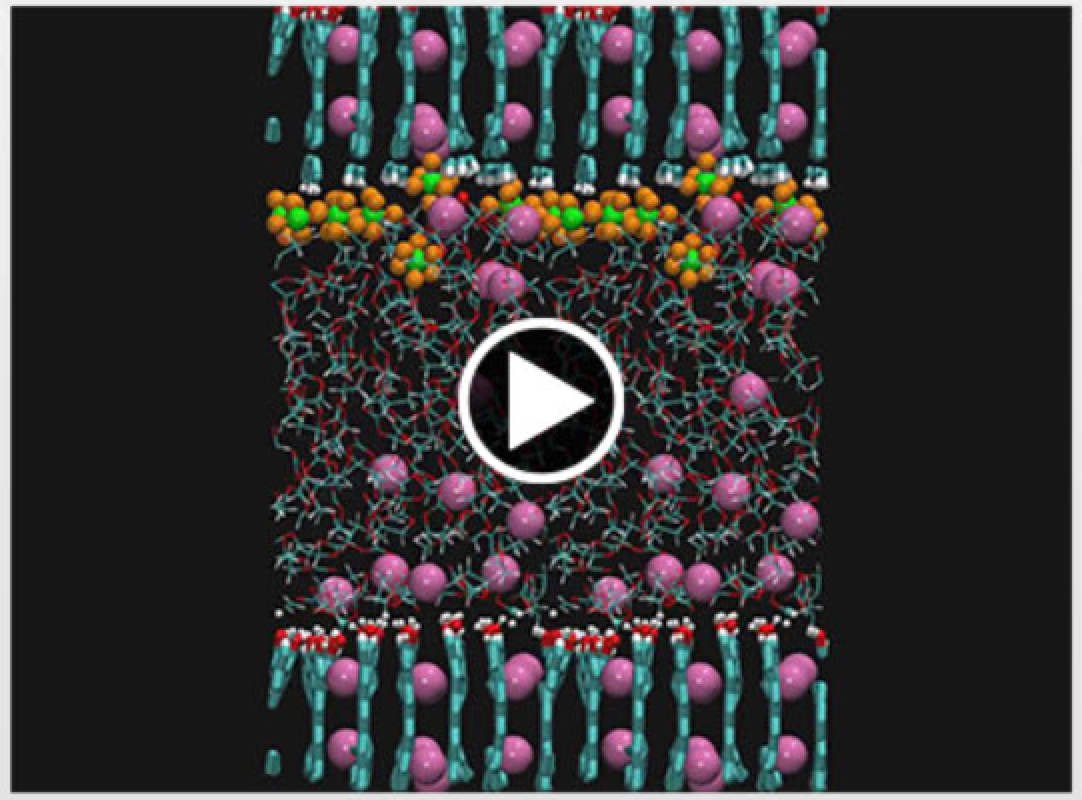


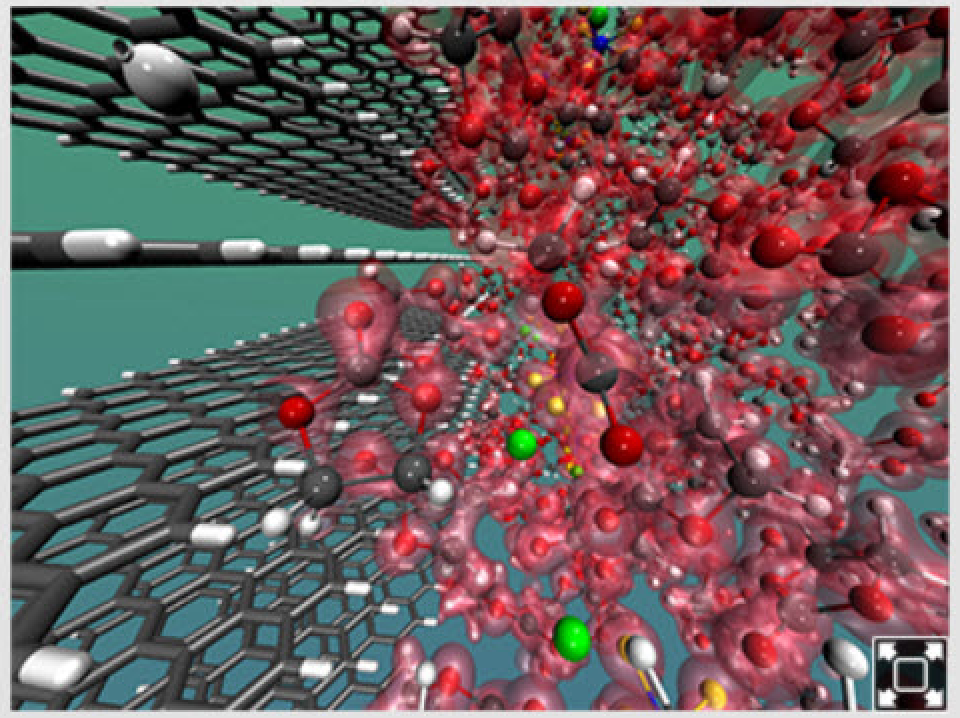
Lawrence Livermore National Laboratory

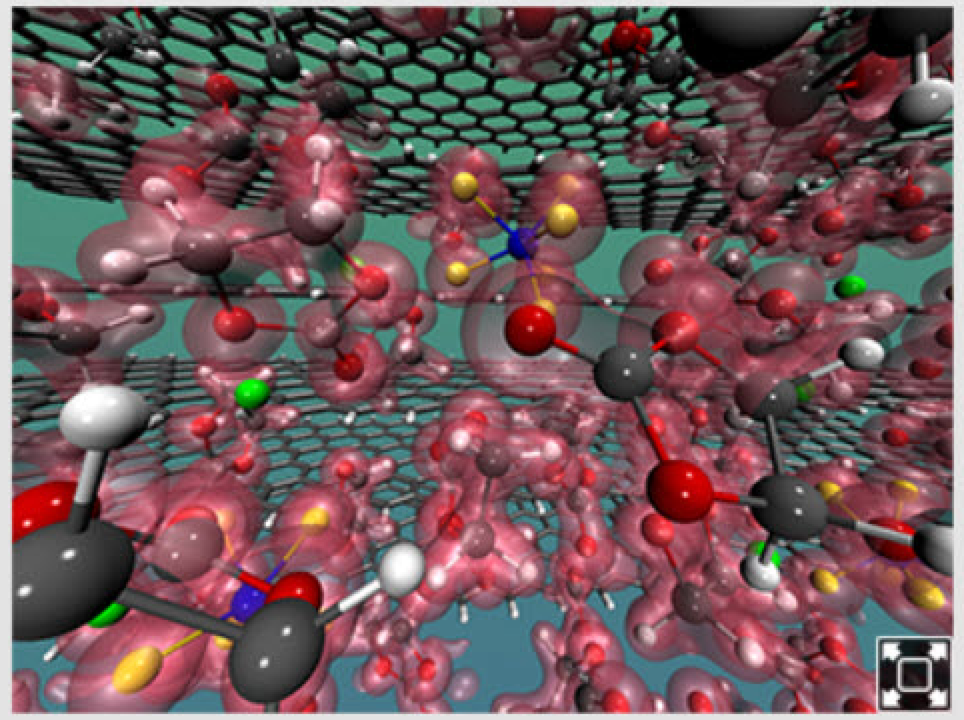
LLNL Leads Initiative to Improve Lithium Ion Batteries

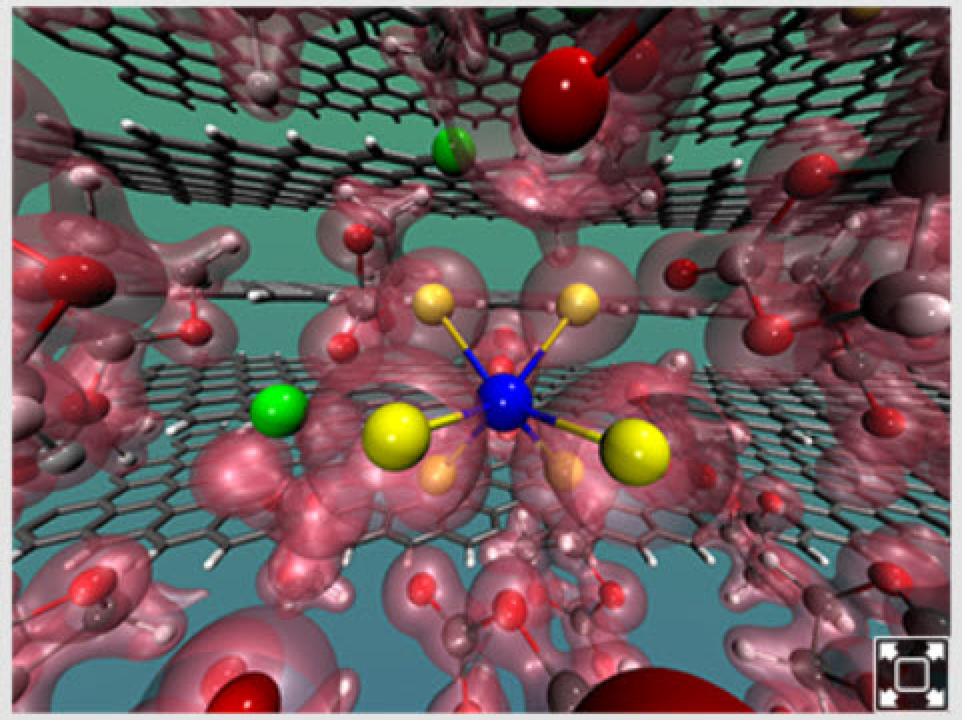
Researchers at the Lawrence Livermore and Lawrence Berkeley National Laboratories are collaborating to carry out quantum-mechanical simulations on the world's largest supercomputers in order to understand the chemical reactions occurring at the anode-electrolyte interface in Lithium Ion Batteries (LIBs). Catastrophic failure of a lithium ion battery can lead to a dangerous scenario, as overheating can cause ignition of certain flammable components. With LIBs finding increasing ubiquity with use in portable electronics and more recently electric vehicles and aircraft, the fire hazard has caught mainstream attention. Numerous reports of laptops bursting into flames can be found; a particularly high profile recent incident led to the grounding of Boeing's 787 Dreamliner aircraft, which required increased fireproofing of onboard LIBs to mitigate the risk of ignition. Various failure modes can lead to LIB overheating and ignition. Often, a short circuit is caused by degradation of one or more components of the battery. One potential culprit is the solid-electrolyte interphase (SEI) layer, a complex solid phase that forms between the anode (typically graphite) and electrolyte as the electrolyte decomposes during operation. Little is known about the detailed chemistry of formation and evolution of the SEI layer, and thus possible mechanisms of failure. In addition, better chemical understanding is necessary to enable the design of new anode-electrolyte combinations for safe, reliable, high-capacity, high-charge rate batteries that avoid the use of flammable materials and remain stable.











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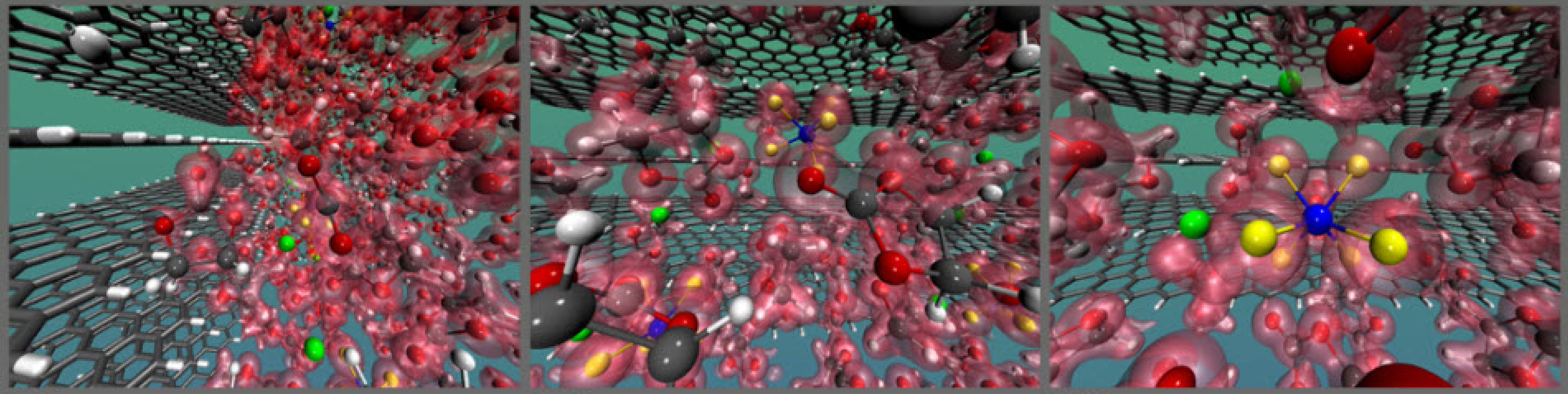
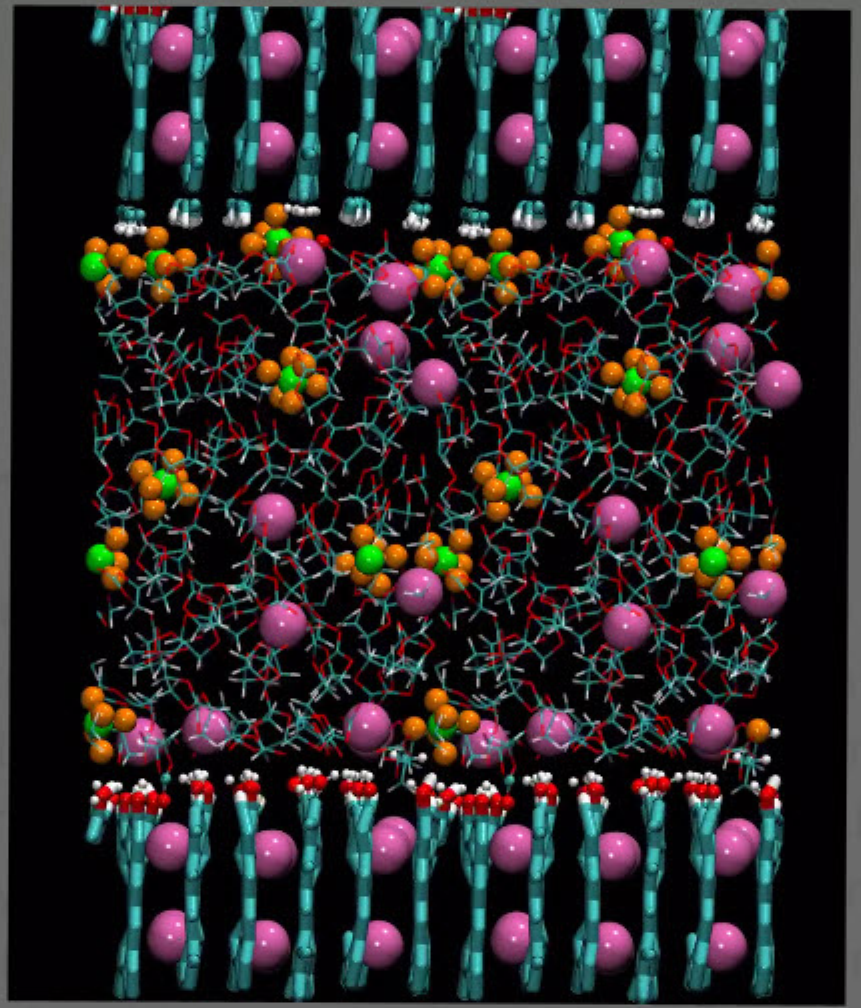


Images (a, b, c) showing a quantum-mechanical molecular dynamics simulation of an electrolyte liquid (ethylene carbonate mixed with lithium phosphohexafluoride) in contact with a graphite anode. From left to right, the images show the interface region (a) as it moves into and through the electrolyte (b), and finally zooms onto a few molecules to highlight a decomposition chemical reaction occurring on the graphite surface (c). In the images, the quantum mechanical nature of the simulation is manifested by the transparent isosurfaces of the electronic charge density, which reveals the chemical reactivity of the components and charge transfer between them.

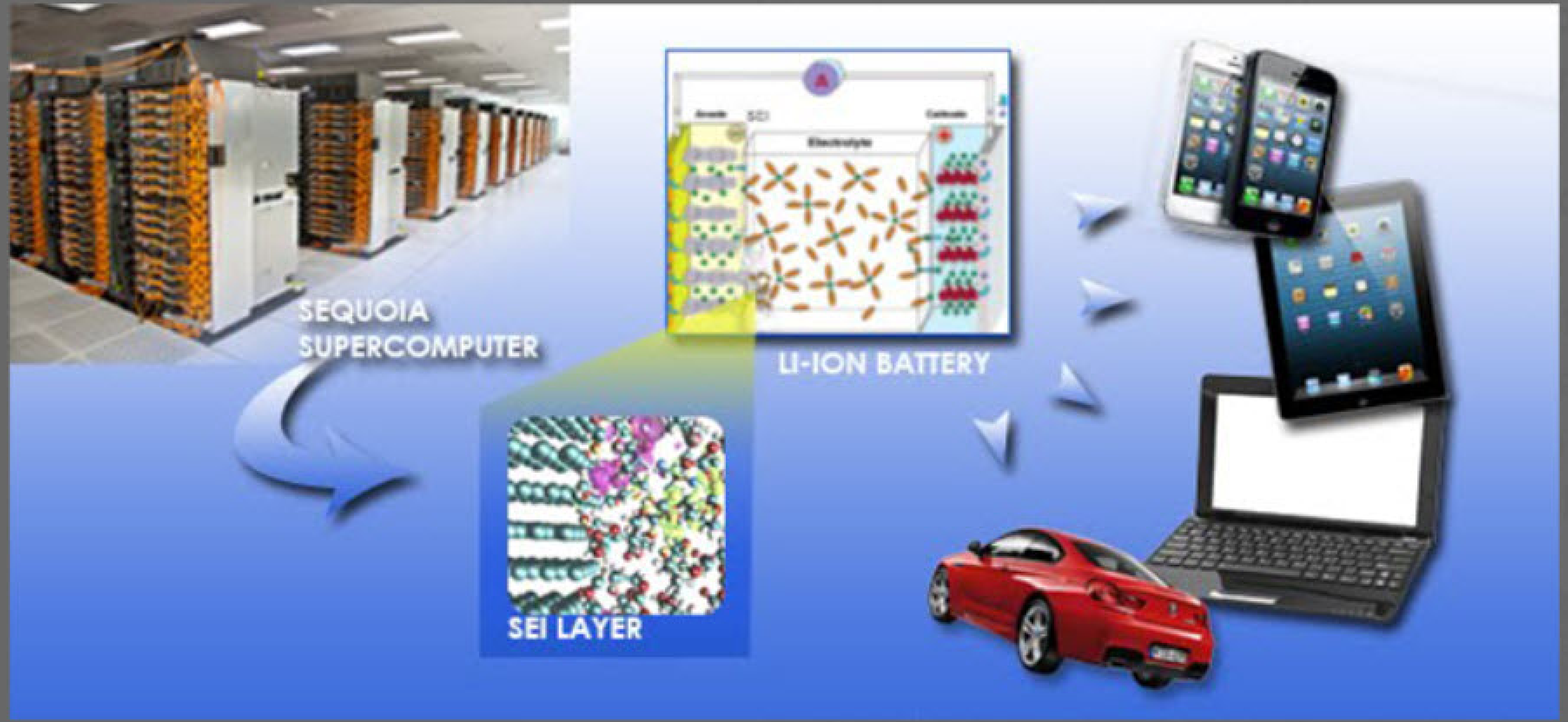


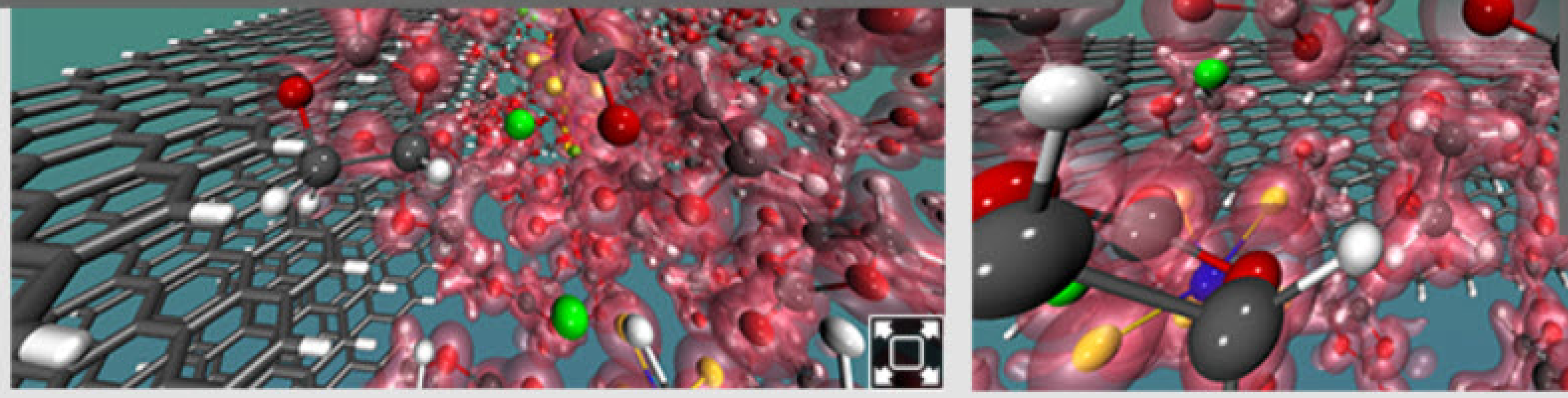
Simulation movie corresponding with images (A, B, and C)

KEY:
Lithium ions (pink)
graphite anode (blue bands)
phosphohexafluoride ions (orange/green)
ethylene carbonate (small red/blue)

National Laboratory

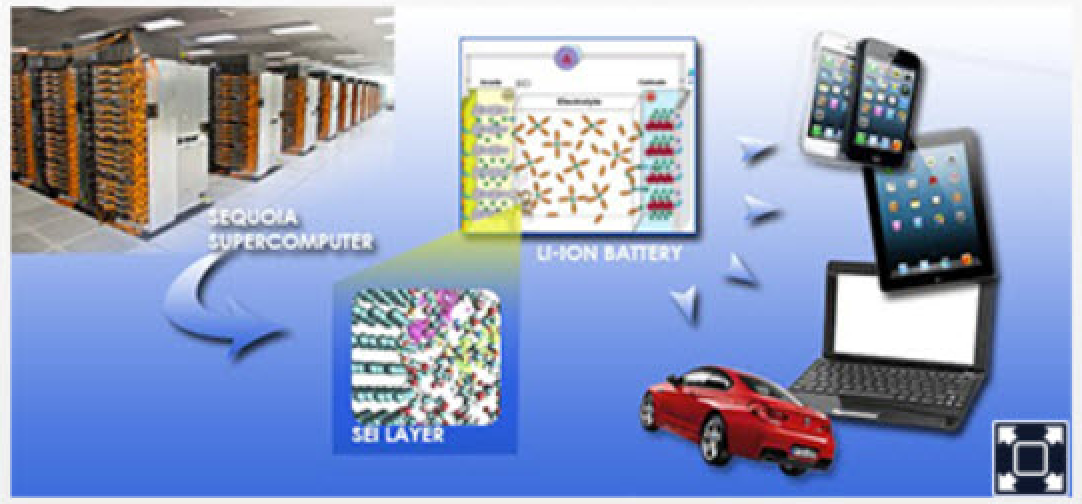
quantum-mechanical simulations on the world's large

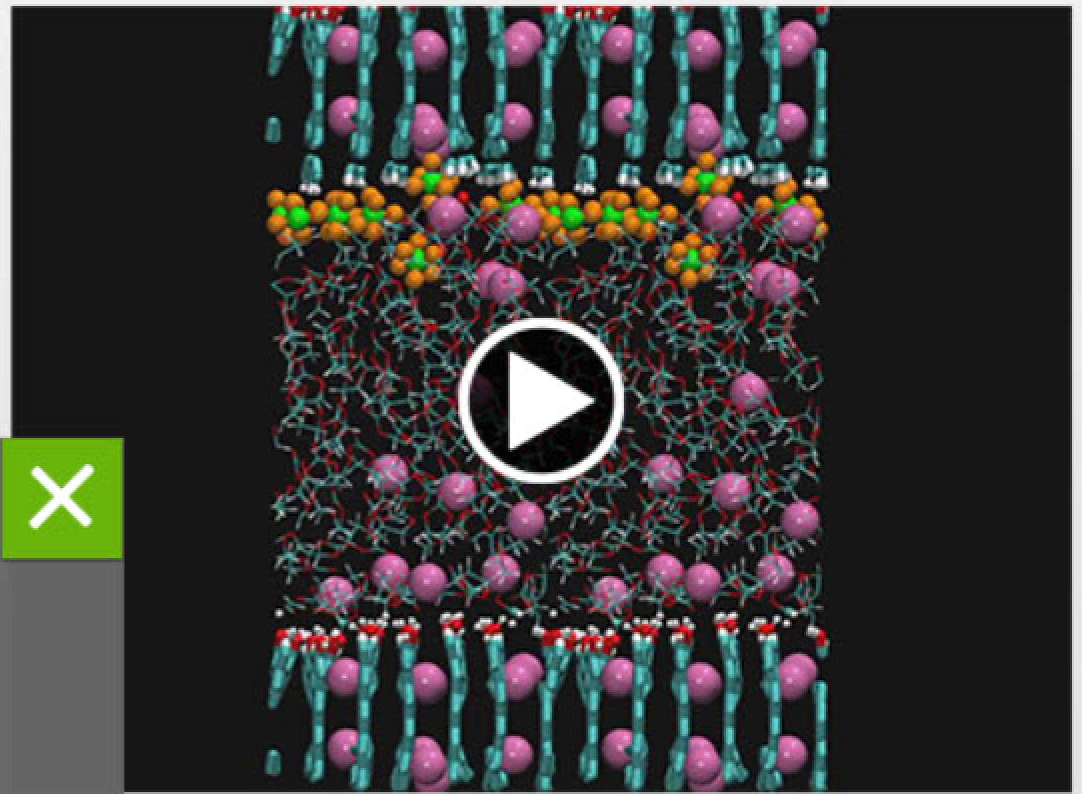




AUTHORS: John Pask, Vincenzo Lordi, Erik Draeger, Mitchell Ong, (Lawrence Livermore National Laboratory) Osvalds Verners, (Pennsylvania State University)

Support for this work has been provided through the Scientific Discovery through Advanced Computing (SciDAC) program funded by U.S. Department of Energy, Office of Science, Advanced Scientific Computing Research and Basic Energy Sciences. This work has been performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.





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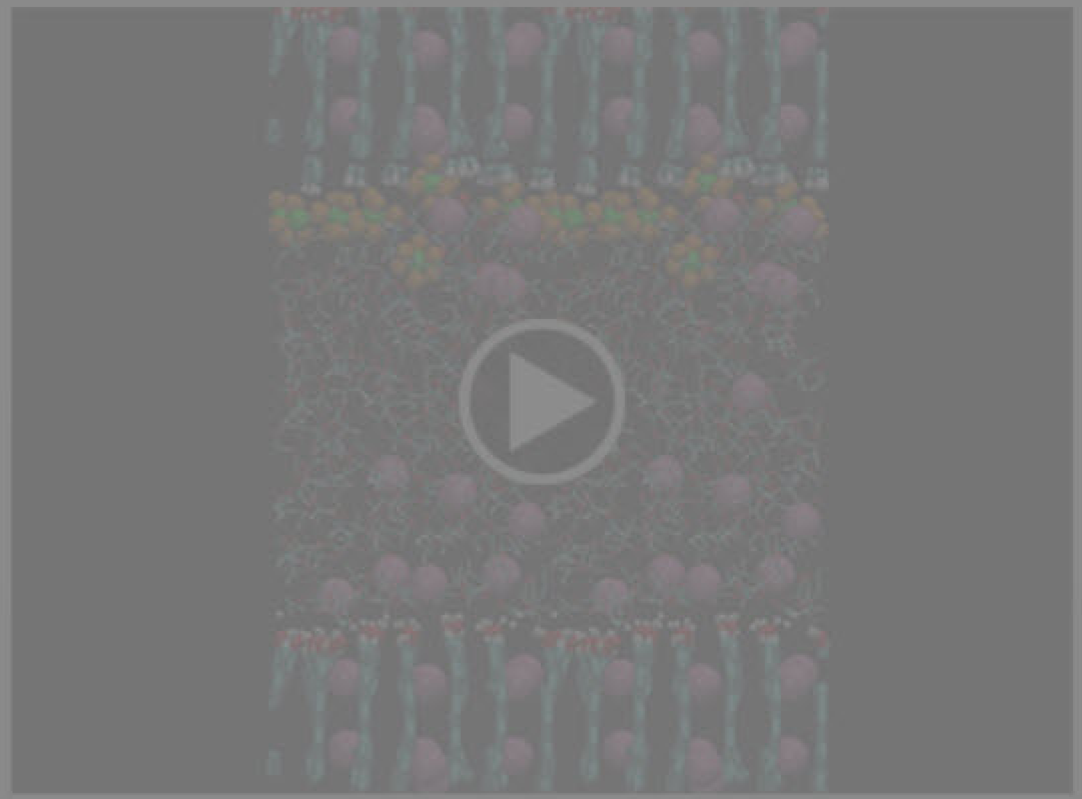

DGDFT-SciDAC

DGDFT: Discontinuous Galerkin Method for Density Functional Theory

Discontinuous Methods for Accurate, Massively Parallel Quantum Molecular Dynamics: Lithium Ion Interface Dynamics from First Principles

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News

- 2013 SciDAC-3 PI Meeting
- Standards Are Tightened for Lithium-Ion Batteries

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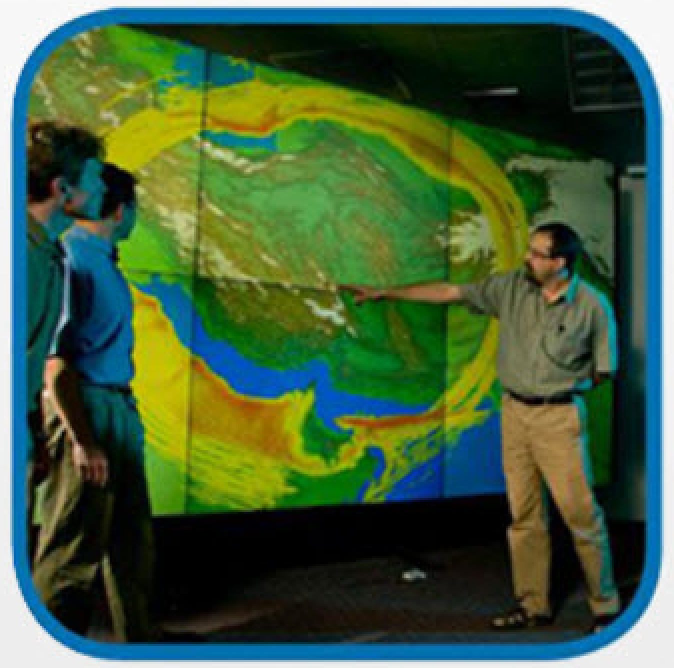

Lawrence Livermore National Laboratory (LLNL) is preeminent in its ability to harness the power of science and technology to address critical national security challenges. Since its inception in 1952, LLNL has embraced its role as a "new ideas" laboratory, focusing on novel concepts and innovative approaches to national security science and engineering.

COMPELLING MISSION

LLNL's defining responsibility is ensuring the safety, security and reliability of the nation's nuclear deterrent. Yet LLNL's mission is broader than stockpile stewardship, as dangers ranging from nuclear proliferation and terrorism to energy shortages and climate change threaten national security and global stability. The Laboratory's science and engineering are being applied to achieve breakthroughs for counterterrorism and nonproliferation, defense and intelligence, energy and environmental security.

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EXCEPTIONAL S&T

The Laboratory's mission requires outstanding capabilities in multiple scientific disciplines, including:

- High-Energy Density Physics
- High-Performance Computing
- Nuclear Science and Technology
- Materials Science
- Advanced Lasers and Diagnostics
- Engineering Development and Systems Technologies

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KEY FACILITIES

The Laboratory supports a number of unique facilities that are central to its ability to carry out its national security mission:

- National Ignition Facility
- Terascale Simulation Facility
- National Atmospheric Release Advisory Center
- Forensic Science Center
- Advanced Manufacturing
- Site 300: Remote site for high explosives and environmental testing.
- Center for Accelerator Mass Spectrometry Livermore Valley Open Campus

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LAB AT A GLANCE

Location: Livermore, California
Type: Multi-program national security laboratory
Contract Operator: Lawrence Livermore National Security, LLC
Principal Sponsor: National Nuclear Security Administration, Department of Energy
Director: Bill Goldstein
Website: http://www.llnl.gov/

PHYSICAL ASSETS:

- Main Site: 490 facilities (6.9 million gross square feet) on 820 acres
- Site 300: 216 facilities (0.4 million gross square feet) on 7,000 acres
- Replacement plant value: $6.6 billion

HUMAN CAPITAL:

- 5,800 employees (including term employees and post-doctoral fellows)
- 2,600 scientists and engineers (more than 40% of whom are Ph.D.s)
- 700 facility users, visiting scientists, teachers and students

FY 2014 Costs: $1.42 billion

- Weapons activities: 58%
- Safeguards and security: 5%
- Nonproliferation: 10%
- Science and energy: 7%
- Homeland security: 3%
- Department of Defense: 13%
- Non-federal: 4%

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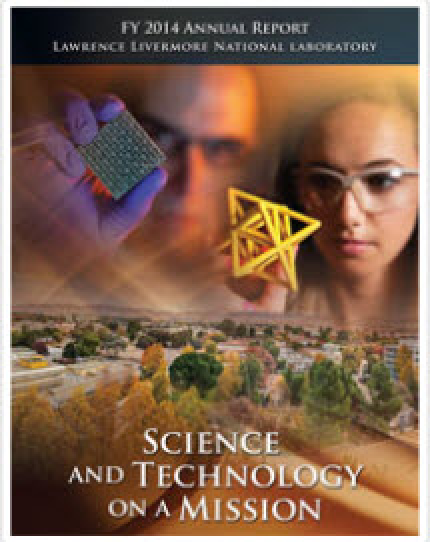
FY2014 Annual Report: Science and Technology on a Mission



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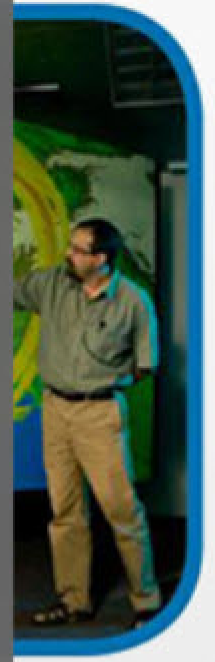

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SCIENCE AND TECHNOLOGY

Expanding the boundaries of scientific knowledge and advancing the technological state of the art to solve problems of national and global importance

Science and technology are central to addressing many of the most difficult problems of the 21st century and to understanding the world around us. Research using LLNL's multidisciplinary scientific expertise and its world-class experimental and computational resources leads to exciting discoveries and innovative solutions.

"Catalyzing" Collaborations and Innovation

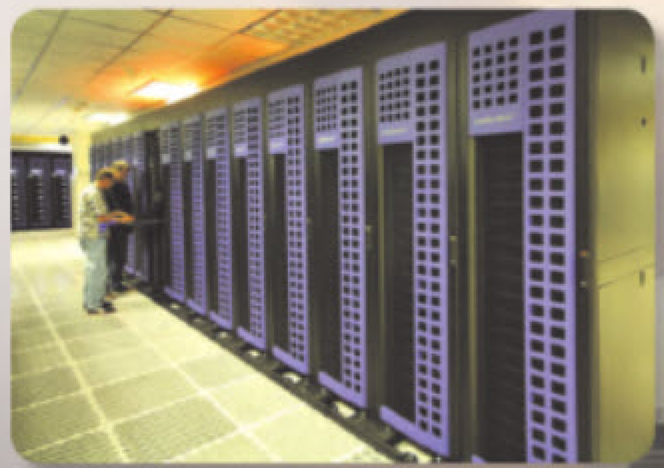
Catalyst, a first-of-a-kind HPC cluster, serves as a proving ground for new HPC and "big data" technologies, architectures, and applications. Developed by a partnership of Cray, Intel, and LLNL, the Cray CS300 system is available through the Laboratory's High Performance Computing Innovation Center for collaborative projects with industry and academia. The machine is specially designed for "big data" research, such as business-data analysis and the advanced sequencing of pathogen genomes. Innovations in data-intensive computing are critical to sustaining U.S. leadership in HPC. Catalyst also supports the Advanced Simulation and Computing program by providing insights into the technologies needed for next-generation nuclear weapons physics simulations.

Four R&D 100 Awards

Lawrence Livermore won four awards in this year's R&D 100 competition. LLNL has received 152 awards since the competition began in 1978. The winning technologies are: a Portable Kit for Detecting Explosives and Drugs, a miniaturized thin-layer chromatography kit that can detect explosives, drugs, and other target substances in samples; the High-Precision Spectrometer for Identifying Trace Elements, a superconducting tunnel junction x-ray spectrometer that can identify unknown substances, such as forensic traces in crime-scene evidence and impurities in computer-chip materials; a Faster, Cheaper System for Polishing Laser Optics, which achieves the precision optics industry's "Holy Grail" of convergence by polishing—quickly, economically, and in a single iteration—optics for imaging systems, lithography, and fusion research; and EXUDE, which allows beams from many small lasers to be combined into a single high-power beam, with applications in advanced defense systems and material processing.

Implantable Technologies for the Brain

The Laboratory is finding wide application for its innovative biocompatible neural interface technologies, which were first used in the artificial retina project. A widely recognized technological breakthrough, the artificial retina partially restores the vision of blind patients. LLNL is developing an implantable neural interface capable of recording and stimulating neurons in the brain to help treat conditions such as post-traumatic stress disorder, traumatic brain injury, and chronic pain. Researchers are also developing the world's first neural device to restore memory loss caused by Alzheimer's disease and other devastating disorders. The goal is an implantable device that stimulates neural tissues to bridge gaps in an injured brain. The implant will connect wirelessly to an external system worn around the ear.



With the system's increased storage capacity and ability to rapidly search massive databases, Catalyst opens opportunities for exploring data-intensive applications such as machine learning and video analytics.

In a unique biomedical research facility at LLNL dedicated to such work, researchers handle a silicon wafer containing micromachined neural devices for implantation inside the human brain.

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Unique Facilities and Centers

One-of-a-kind experimental facilities, world-class computing resources and specialized centers of expertise at Lawrence Livermore National Laboratory (LLNL) enable researchers to achieve science and technology breakthroughs that strengthen the nation's security, well-being and prosperity.

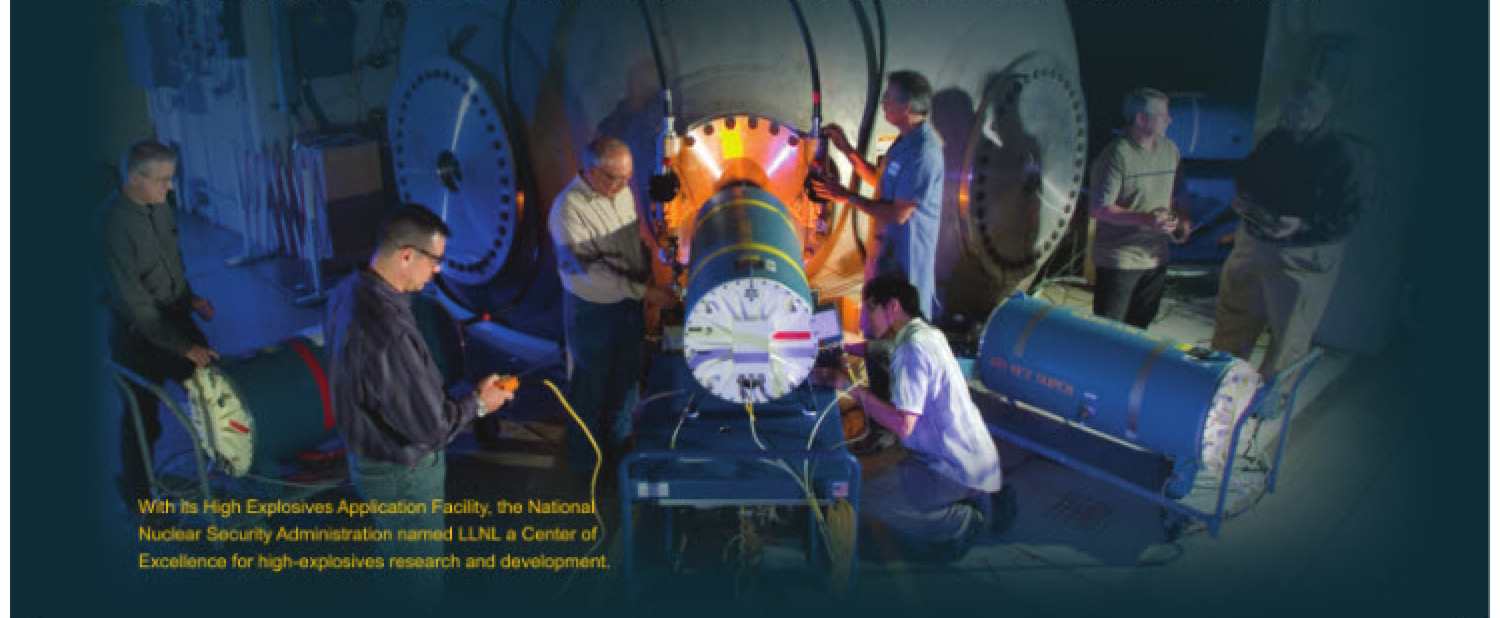
Modern scientific research is built upon the triad of theory, experiment and simulation. In order to carry out its national security mission, LLNL has designed and constructed a host of one-of-a-kind experimental facilities and has collaborated with industry to develop and deploy successively more powerful and more capable supercomputers. These resources have been integrated to create a number of centers of excellence that provide unique capabilities of solving problems of scientific and national security importance. Some of LLNL's special facilities and centers are highlighted below.

National Ignition Facility (NIF). The 192-beam facility is the largest and most energetic laser system in the world. As the only facility capable of creating the conditions necessary for fusion ignition – the source that powers the sun and stars – in a laboratory setting, NIF is a critical experimental facility for stockpile stewardship. NIF also is an important international scientific resource for investigating the properties of materials at extreme conditions and the feasibility of fusion energy as a future power source.

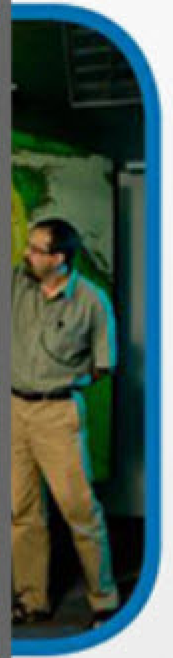
Terascale Simulation Facility (TSF). The Laboratory is home to some of the world's fastest supercomputers, among them Sequoia and Vulcan. These machines can perform trillions of operations per second – in fact, a calculation that would take an entire day in 1995 now takes one second. The super machines explore a broad range of science, from ensuring the safety and reliability of the nation's aging nuclear deterrent to complex simulations ranging from energy research, drug development and understanding of the human heart.

High Explosives Research. LLNL is a global leader in explosives testing. The Contained Firing Facility (CFF) is a modern hydrodynamic testing facility that conducts experiments using up to 60 kilograms of high explosives. Located at the Lab's nearby test facility known as Site 300, CFF provides full containment of all explosive debris for high-quality environmental management. Located at the Lab's main site, the High Explosives Application Facility (HEAF) is a state-of-the-art facility for the research and development, synthesis and formulation, and characterization and testing of explosives. HEAF has seven fully contained firing tanks for testing explosive quantities up to 10 kilograms and a specially designed firing tank for high-velocity studies.

National Atmospheric Release Advisory Center (NARAC). NARAC is a national resource for predicting the spread of hazardous materials released, accidentally or intentionally, into the atmosphere. NARAC provides plume predictions within minutes of a release for emergency managers to use in response to myriad disasters, from industrial fires in the wake of Hurricane Katrina, to the Chernobyl and Fukushima nuclear power plant releases to volcanic eruptions in the Philippines and Hawaii.



With its High Explosives Application Facility, the National Nuclear Security Administration named LLNL a Center of Excellence for high-explosives research and development.



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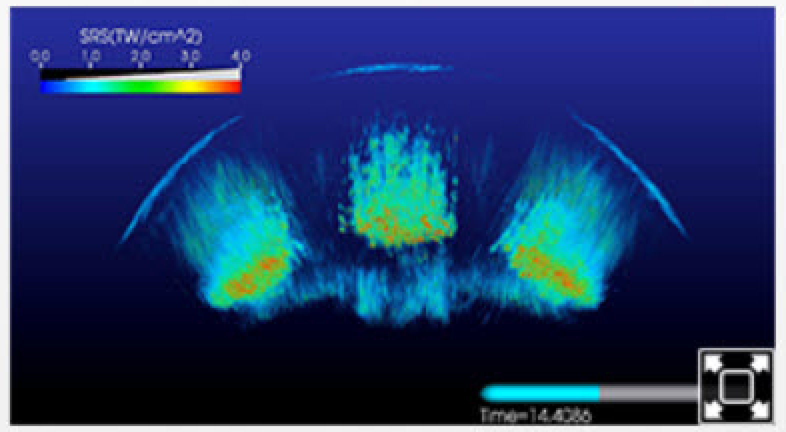
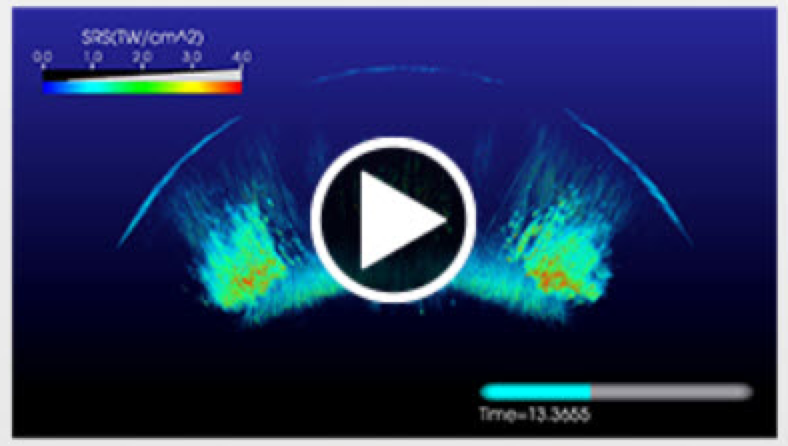
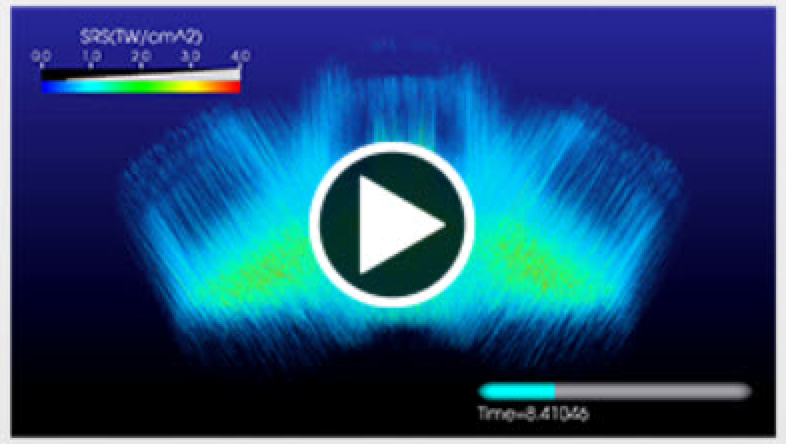
National Ignition Facility Laser-Plasma Interaction Simulations

Scientists have been working to achieve self-sustaining nuclear fusion and energy gain in the laboratory for more than half a century. When the National Ignition Facility (NIF) began ignition experiments at Lawrence Livermore National Laboratory (LLNL) in 2010, that long-sought goal became much closer to realization.







This simulation demonstrates laser beam propagation with backscatter inside an ignition target. The laser-plasma interaction code pF3d, was used to model the propagation of high intensity laser beams through plasma with Stimulated Raman Scattering (SRS). The simulation demonstrates laser-plasma interactions from three "quads" (groups of 2x2 laser beams) in an experiment performed at the NIF at LLNL. These types of simulations help optimize NIF target performance.

The SRS has a "bursty" character and, at the peak, backscatters a significant fraction of the laser light. The effects of the scattered light can be seen in the first movie visualization where the intensity at the back of the box periodically drops (becomes bluer). The SRS bursts are very obvious in the second movie visualization. The level of SRS is highly time-dependent and there is a time delay between the outer quads to the middle quad. The movies were created using VisIt visualization software.

LLNL's National Ignition Facility houses 192 giant lasers in a ten-story building the size of three football fields. It delivers at least 60 times more energy than any previous laser system. When all of its beams are employed, NIF focusses nearly two million joules of ultraviolet laser energy on a tiny target in the center of its target chamber – creating conditions similar to those that exist only in the cores of stars and giant planets and inside a nuclear weapon. The resulting fusion reaction will release many times more energy than the laser energy required to initiate the reaction.

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MORE INFO

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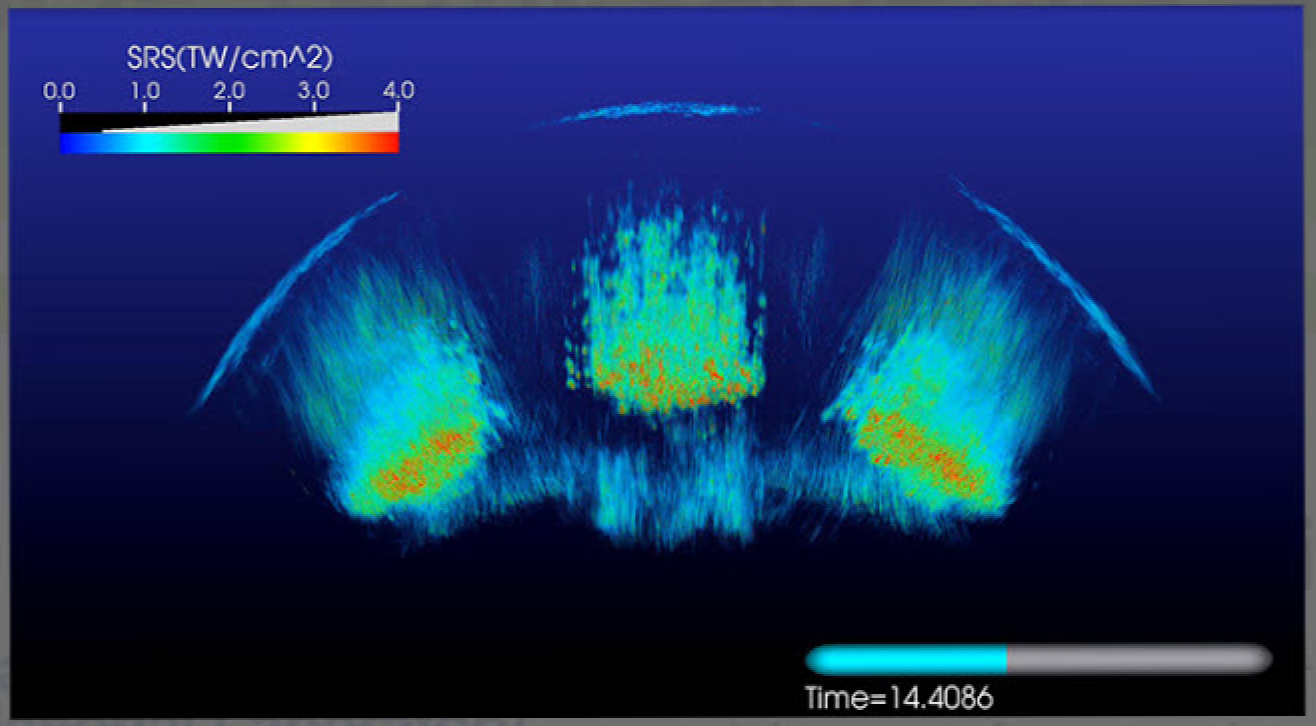
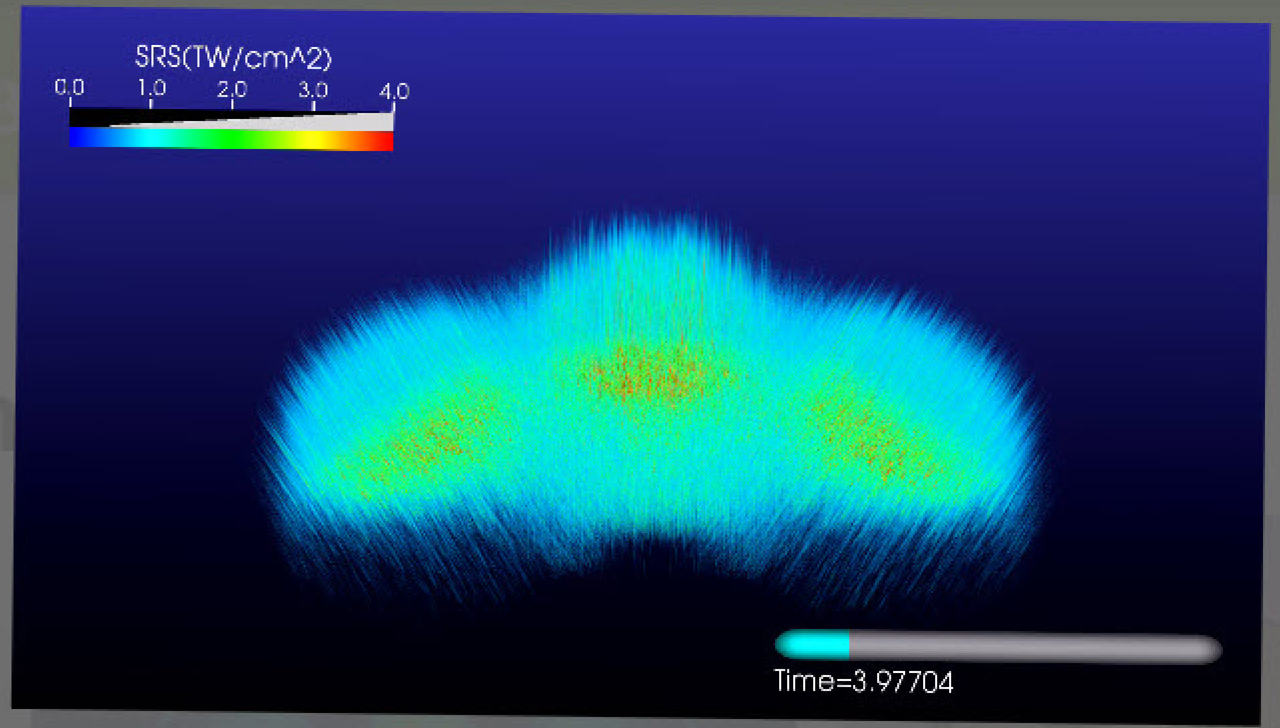


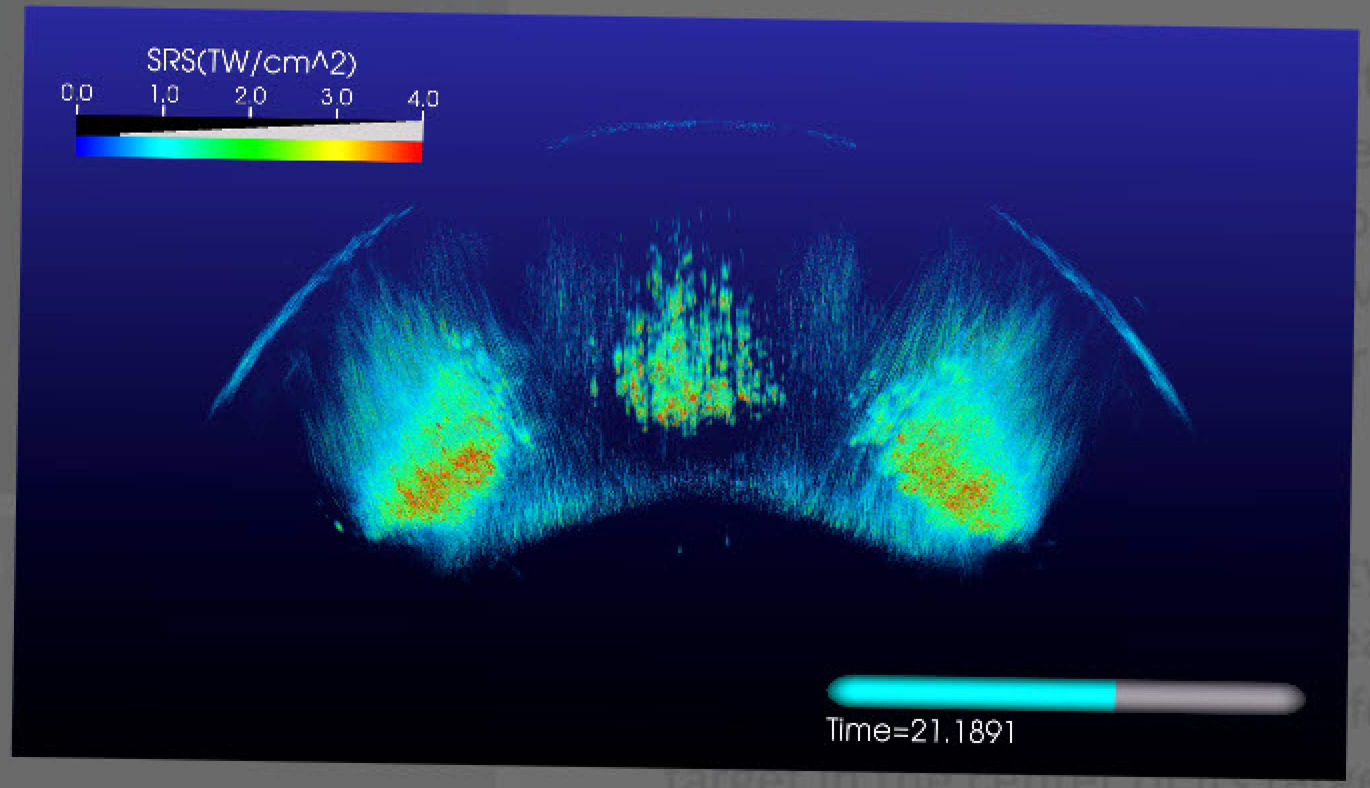
An image from the NIF laser beam backscatter simulation. Laser light enters the target and resonantly scatters off ion acoustic waves and electron plasma waves. The color bar shows the intensity ranging from blue (low intensity) to red (high intensity) using Stimulated Raman Scattering (SRS). SRS starts at a few points towards the back of the simulation and grows in both strength and transverse extent as it propagate back towards the entrance plane.

Lawrence Livermore National Laboratory's National Ignition Facility.

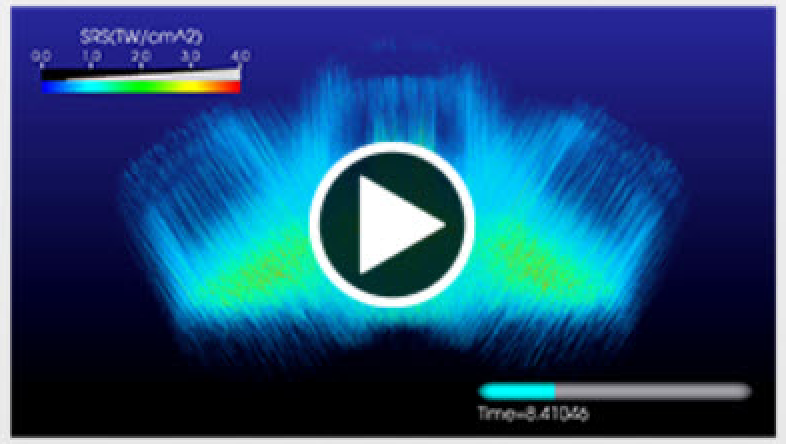


Movie simulation #1: Demonstrates periodic intensity of backscattered light.

This simulation demonstrates laser beam propagation with backscatter inside an ignition target. The laser-plasma interaction code pF3d, was used to model the propagation of high intensity laser beams through plasma with Stimulated Raman Scattering (SRS). The simulation demonstrates laser-plasma interactions from "quads" (groups of 2x2 laser beams) in an experiment performed at the NIF at LLNL. These types of simulations help optimize NIF target performance.



Movie simulation #2: Demonstrates time dependent backscatter bursts



DOE LAB: Lawrence Livermore National Laboratory

FUNDING AGENCY: National Nuclear Security Administration (NNSA) Advanced Simulation & Computing (ASC) program.

PRINCIPAL INVESTIGATORS: Bert Still, Steve Langer, LLNL

RESOURCE: Cielo, Los Alamos National Laboratory, 65K cores used

ARCHITECTURE: Cray XE6

LLNL-POST-645033

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U.S. DEPARTMENT OF ENERGY

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National Ignition Facility & Photon Science

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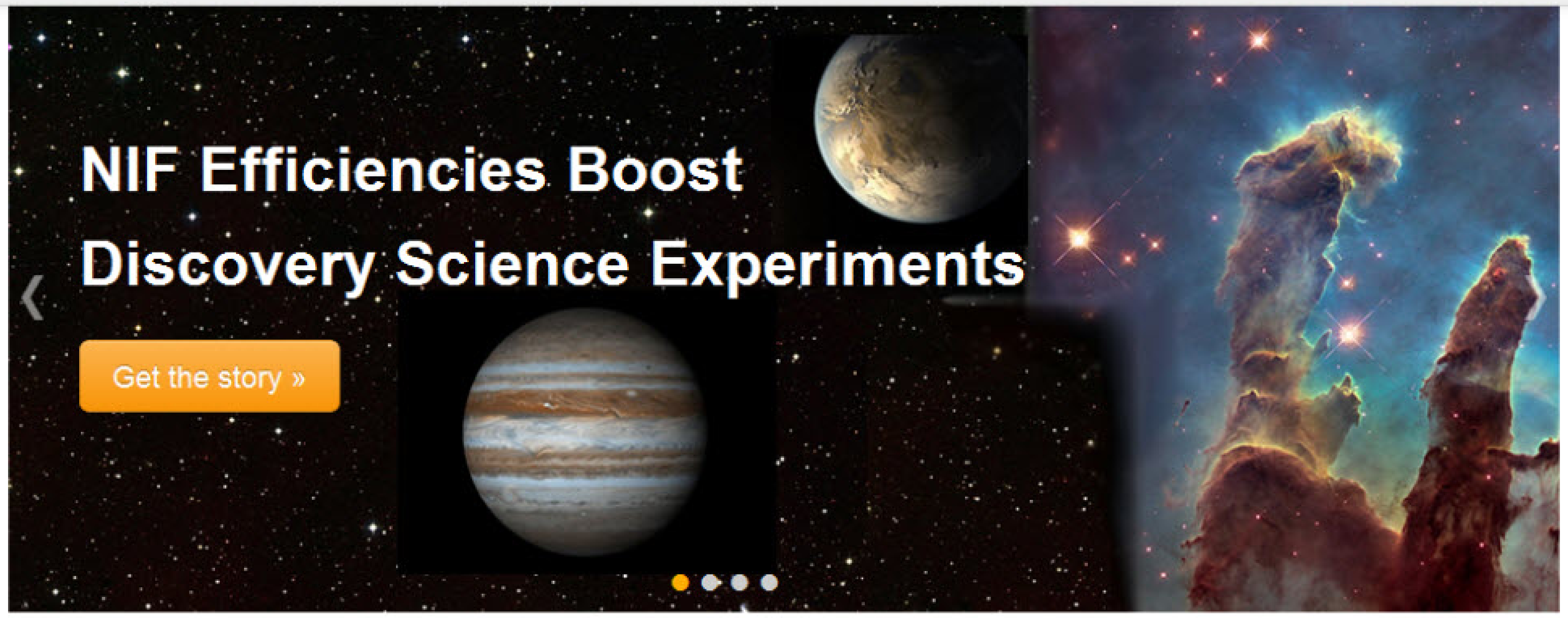

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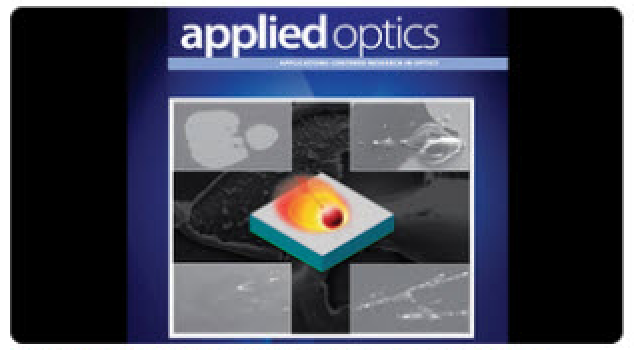
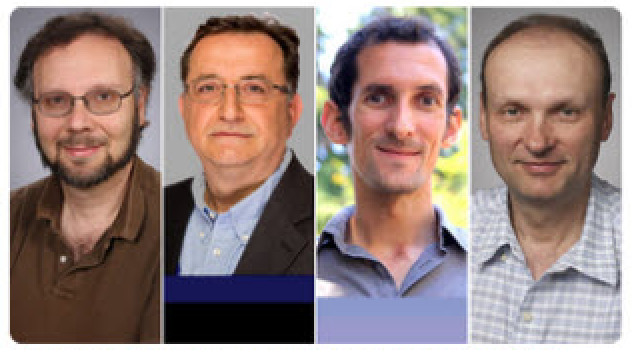


Protecting Mirrors Against Laser Damage
Studies look to limit damage to protective layers of mirror coatings caused by surface contaminants.



American Physical Society Names Fellows
Lee Bernstein, Stavros Demos, Pierre Michel, and Vladimir Smalyuk selected as 2015 APS Fellows.

Target-Assembling Robots
New universal robotic target assembly robots are installed in the NIF target fabrication facility.

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Our Science

National Security
ensuring the nuclear deterrent

Energy Future
clean, limitless power

Discovery Science
understanding the universe

National Competitiveness
inspiring science

https://lasers.llnl.gov/

Nationa...

Scientists hav... laboratory for... experiments a... became much...

This simulatio... The laser-plas... beams throug... laser-plasma i... performed at...

The SRS has a... light. The effe... intensity at th... obvious in the... time delay be... visualization s...

LLNL's Nationa... football fields... its beams are... target in the c... the cores of st... release many times more energy than the laser energy required to initiate the reaction.

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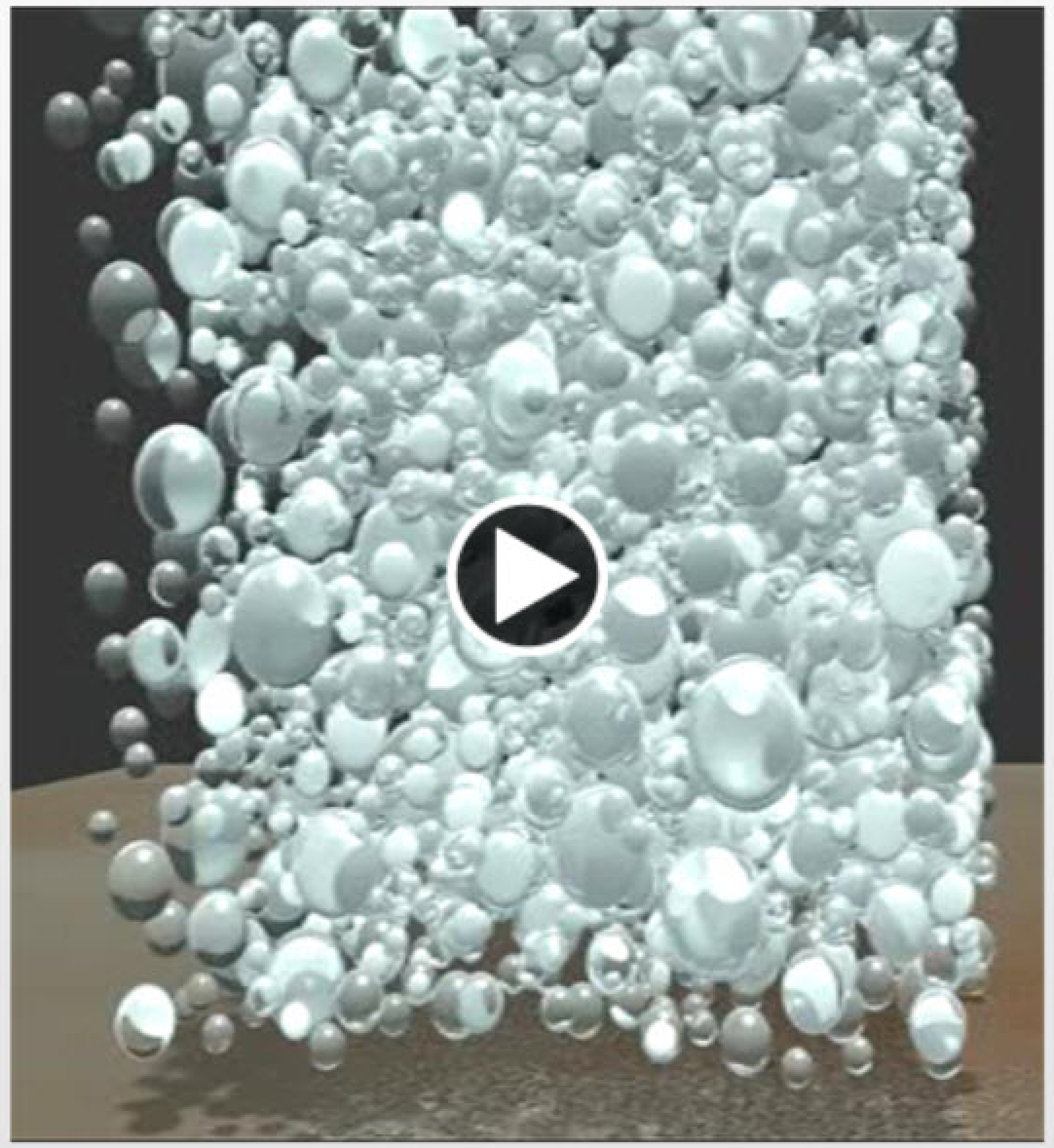
Lawrence Livermore National Laboratory

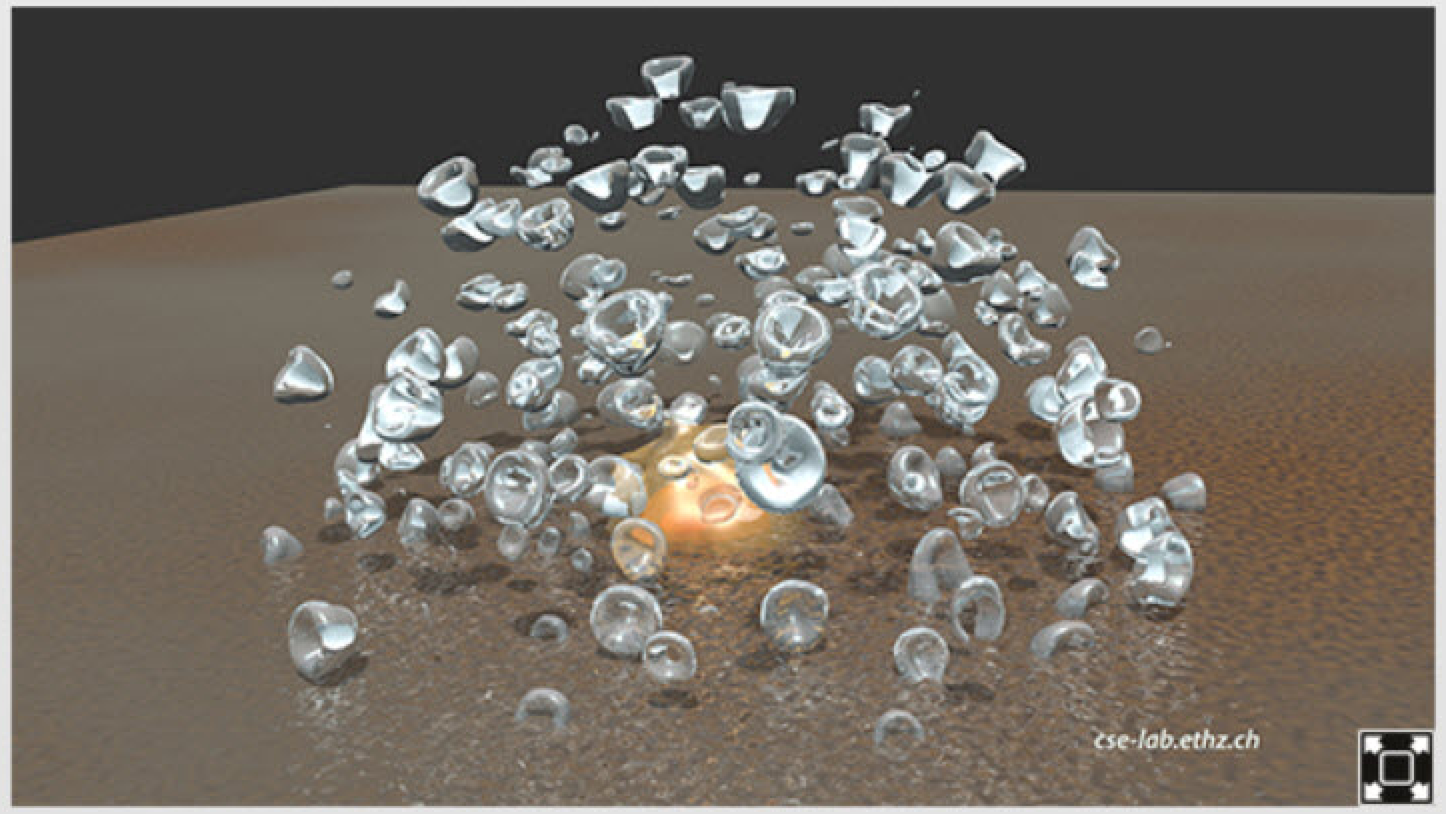
14.4 PFLOPS Simulations of Cloud Cavitation Collapse

Scientists at ETH Zurich and IBM Research, in collaboration with the Technical University of Munich and Lawrence Livermore National Laboratory (LLNL), set a record in supercomputing in Fluid Dynamics using 6.4 million threads on LLNL's 96 rack Sequoia IBM BlueGene/Q, one of the fastest supercomputers in the world.

The scientists performed the largest simulation ever in fluid dynamics by employing 13 trillion cells and reaching an unprecedented, for flow simulations, 14.4 Petaflop sustained performance on Sequoia - 73 percent of the supercomputer's theoretical peak. The simulations resolved unique phenomena associated with clouds of collapsing bubbles which have applications ranging from treating kidney stones and cancer to improving the efficiency of high pressure fuel injectors.

This research was awarded the Gordon Bell Prize for peak performance at SC13 in Denver, Colo. The prize was awarded for an 11 Petaflops (11 quadrillion floating operations per second) simulation of cloud cavitation collapse.





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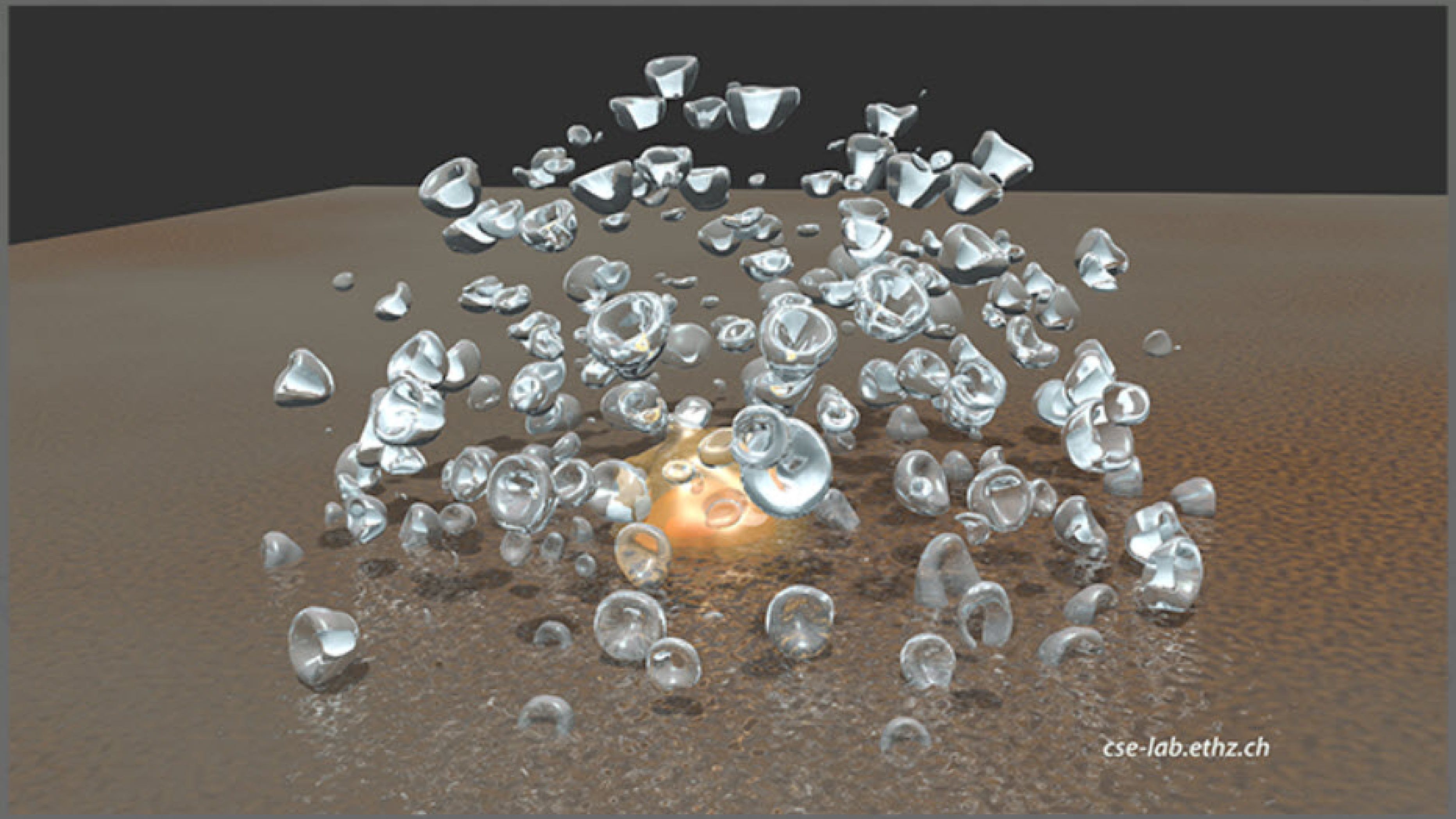
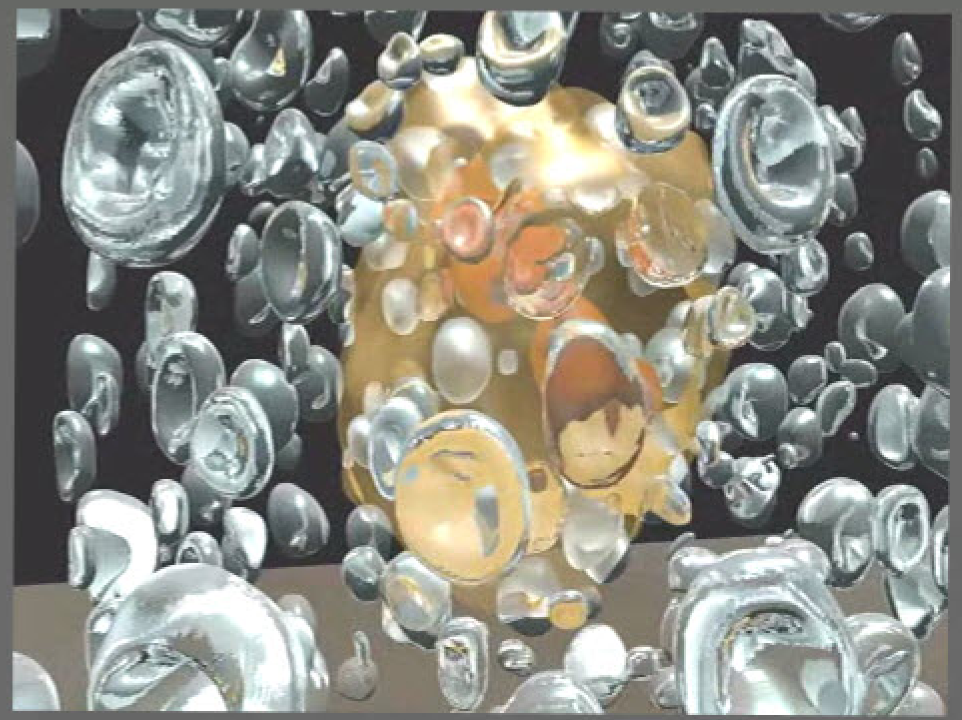


Lawrence Livermore National Laboratory's 20 petaflop Sequoia IBM Blue Gene/Q system.



Simulation movie showing a cloud of collapsing bubbles and the resultant high kinetic energy pressure hot spots (yellow and orange) in the flow field. The maximum pressure is depicted in orange. Courtesy of Babak Hejazialhosseini zVg/CSE Laboratory, ETH Zurich.

...ever in fluid dynamics ... and reaching an unprecedented, for flow simulations, 14.4 Petaflop sustained performance on Sequoia ... percent of the supercomputer's theoretical peak. The simulations resolved unique phenomena associated with clouds of collapsing bubbles which have applications ranging from treating kidney stones and cancer to improving the efficiency of high pressure fuel injectors.

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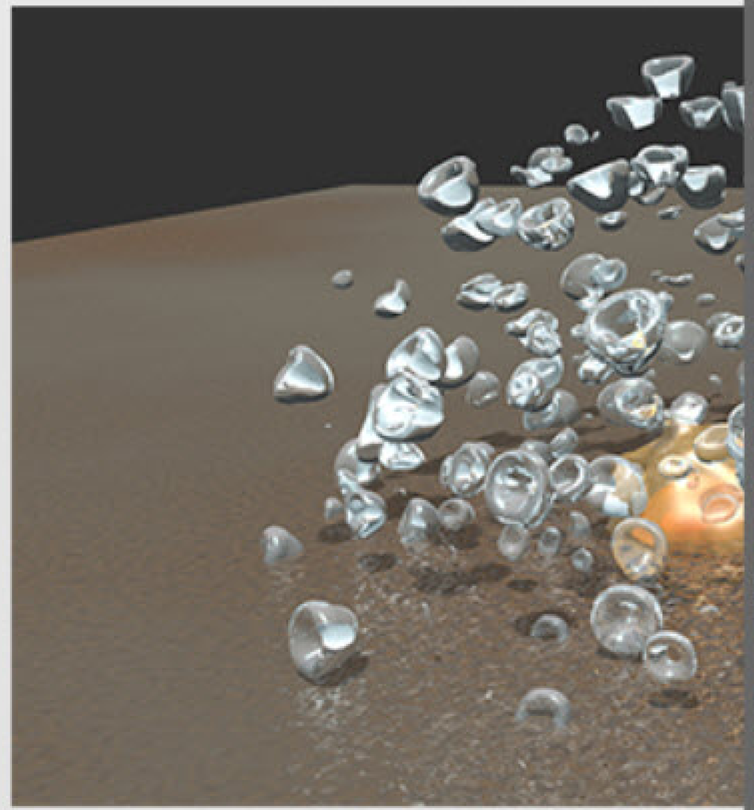

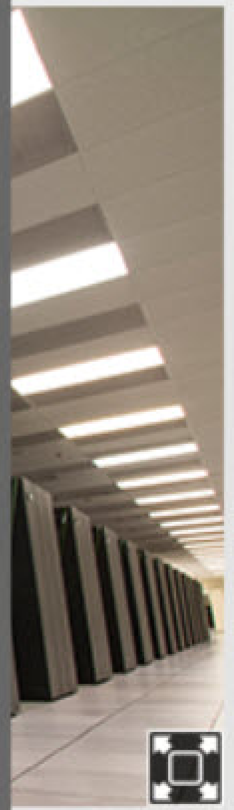

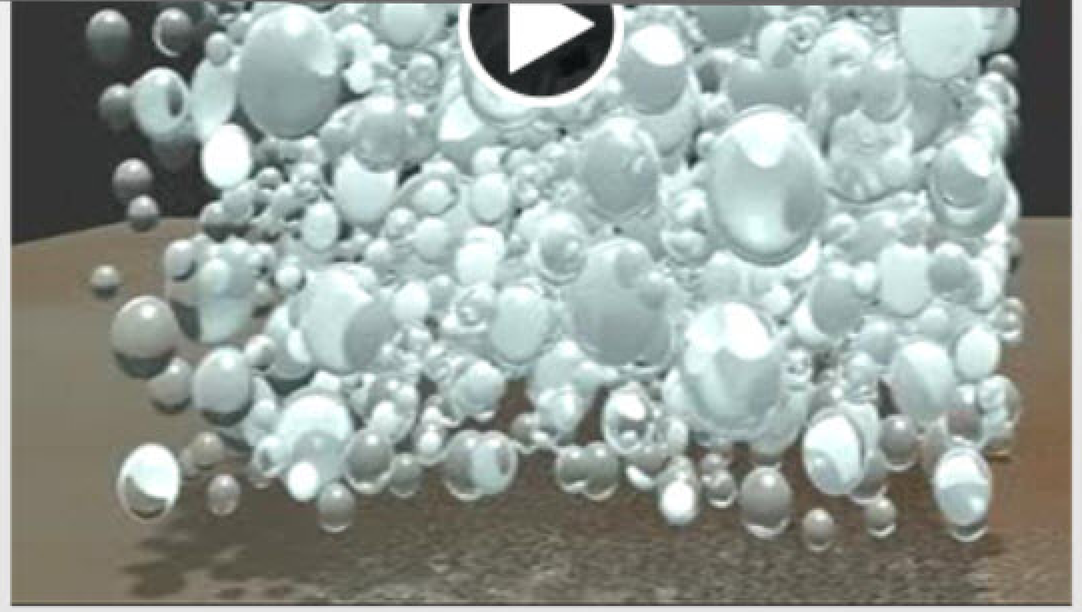

Members of the winning team include: lead author Diego Rossinelli, Babak Hejazialhosseini, Panagiotis Hadjidoukas and Petros Koumoutsakos of ETH Zurich; Costas Bekas and Alessandro Curioni of IBM Zurich Research; Steffen Schmidt and Nikolaus Adams of the Technical University of Munich; Adam Bertsch and Scott Futral of Lawrence Livermore National Laboratory.

DOE LAB: Lawrence Livermore National Laboratory
FUNDING AGENCY: National Nuclear Security Administration (NNSA) Advanced Simulation & Computing (ASC) program.
FUNDING ACKNOWLEDGEMENT: Lawrence Livermore National Security, LLC. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344.

RESOURCE: Sequoia, Lawrence Livermore National Laboratory
ARCHITECTURE: IBM Blue Gene / Q
SCIENCE DOMAIN: Computational Fluid Dynamics

LLNL-WEB-458451

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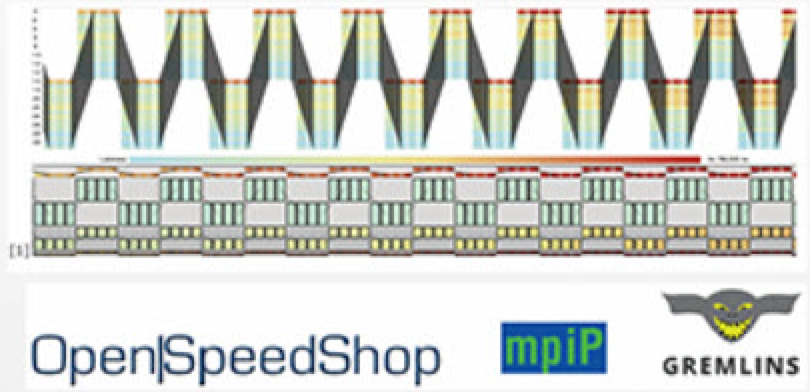


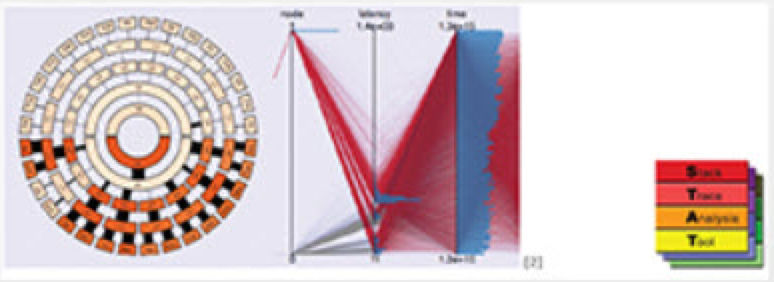
PERFORMANCE ANALYSIS AND VISUALIZATION

Essential tools for application and software stack developers at extreme scale.
Profile, sample and trace: Open|SpeedShop, mpiP.
Emulate behavior on future architectures: GREMLINs.
Visualize and attribute across domains: Boxfish, MemAxes, Ravel.
Map tasks on the interconnect topology: Rubik, Chizu.

TOOL INFRASTRUCTURES

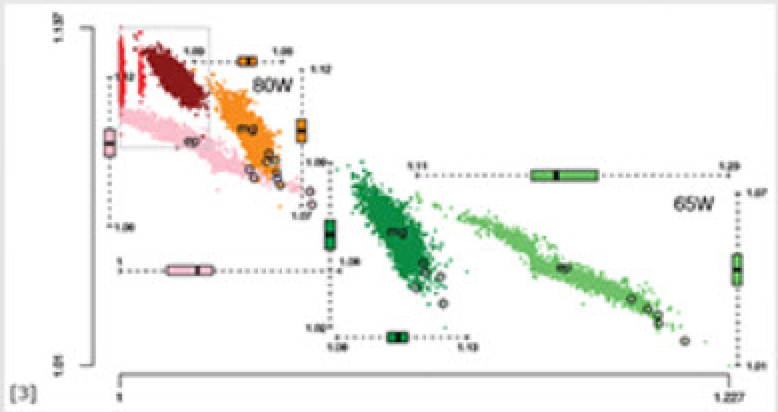
The glue between applications, tools and systems.
Fast library load times: SPINDLE.
PMPI tool interface virtualization: P^NMPI.
Scalable tool components and launch simplification: Cram.

Cram



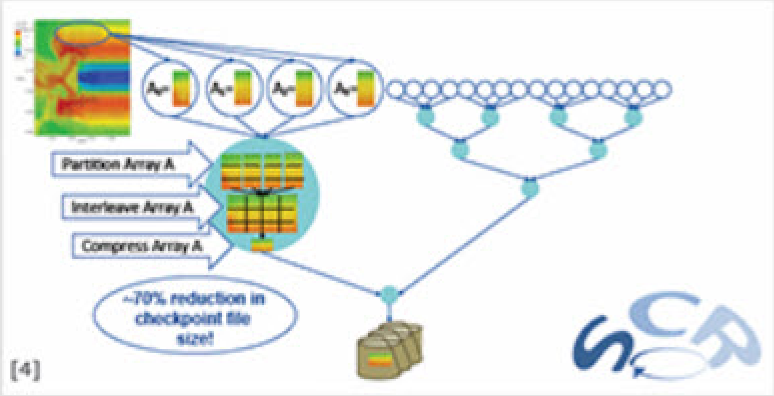
DEBUGGING AND CORRECTNESS

Debugging and verifying correctness on millions of cores.
Debug at extreme-scale: STAT.
Find unencountered MPI usage bugs: MUST.
Identify abnormal behavior using statistical analysis: AutomaDeD.
Create scripts for application-specific debugging: DySectAPI.



POWER-CONSTRAINED COMPUTING

Optimizing performance under a hard system-wide power bound.
Node configuration: choose concurrency levels, processor configurations and node counts.
Runtime: use power from nodes not on crticial path for those on the crtitical path.
Reliability: exploit undervolting and overclocking to improve performance.
Scheduling: reassign power to new or exisiting jobs when a job completes.



TOOLS FOR SCALABLE RESILIENCE

Researching solutions for resilient computing in extreme-scale, high-fault environments.
Checkpoint millions of tasks using a 1 PB/s in-memory file system: CRUISE.
Reduce checkpoint sizes using the checkpoint compression framework: mcrEngine.
Make MPI applications fault-agnostic transparently: Fault-tolerant messaging interface.
Scheduling choices and storage designs for best I/O throughput.
Algorithm-based fault tolerance.

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Scalability@LLNL's participation at SC15

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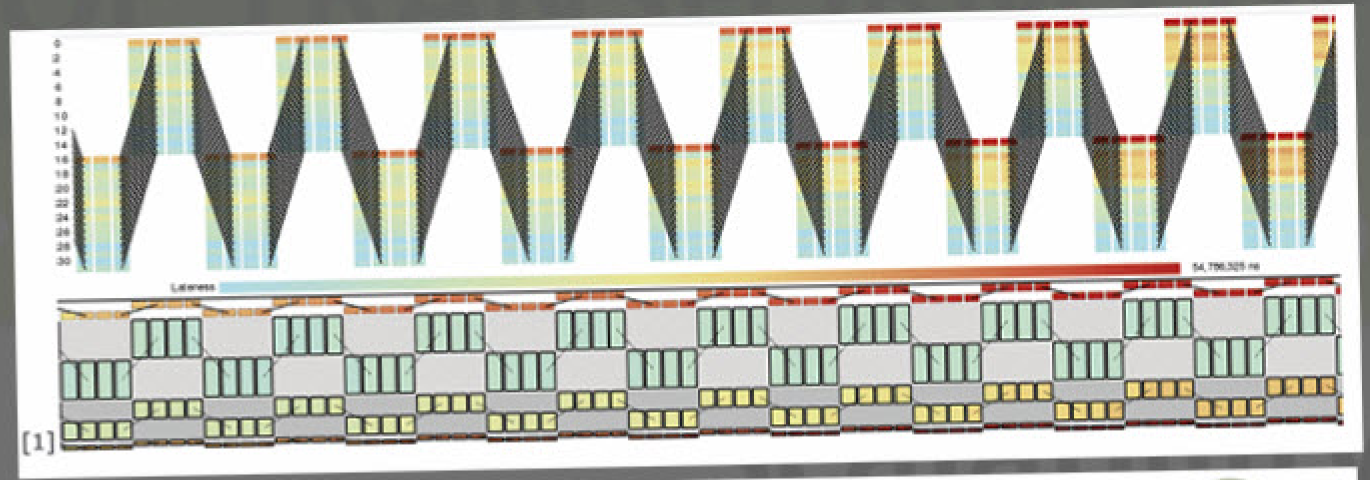
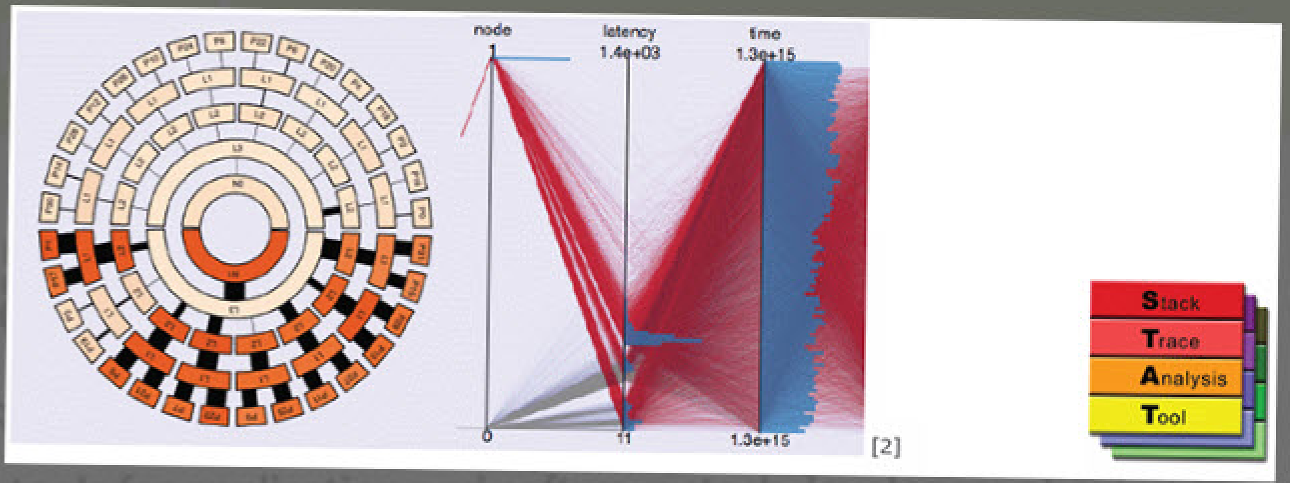
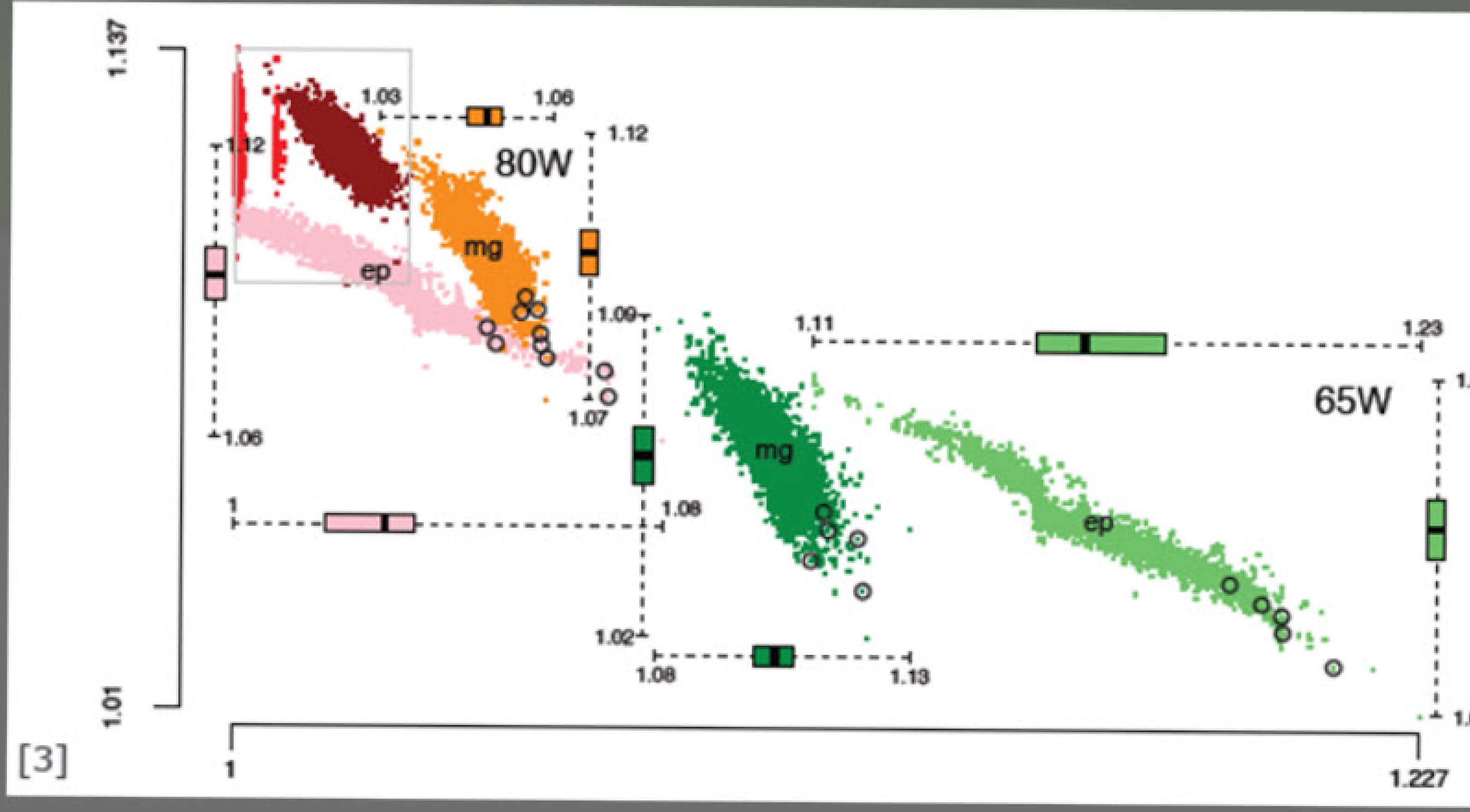
DOE TRANSFORMS HPC


[1]

Open|SpeedShop mpiP GREMLINS



[2]



[3]

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PERFO...

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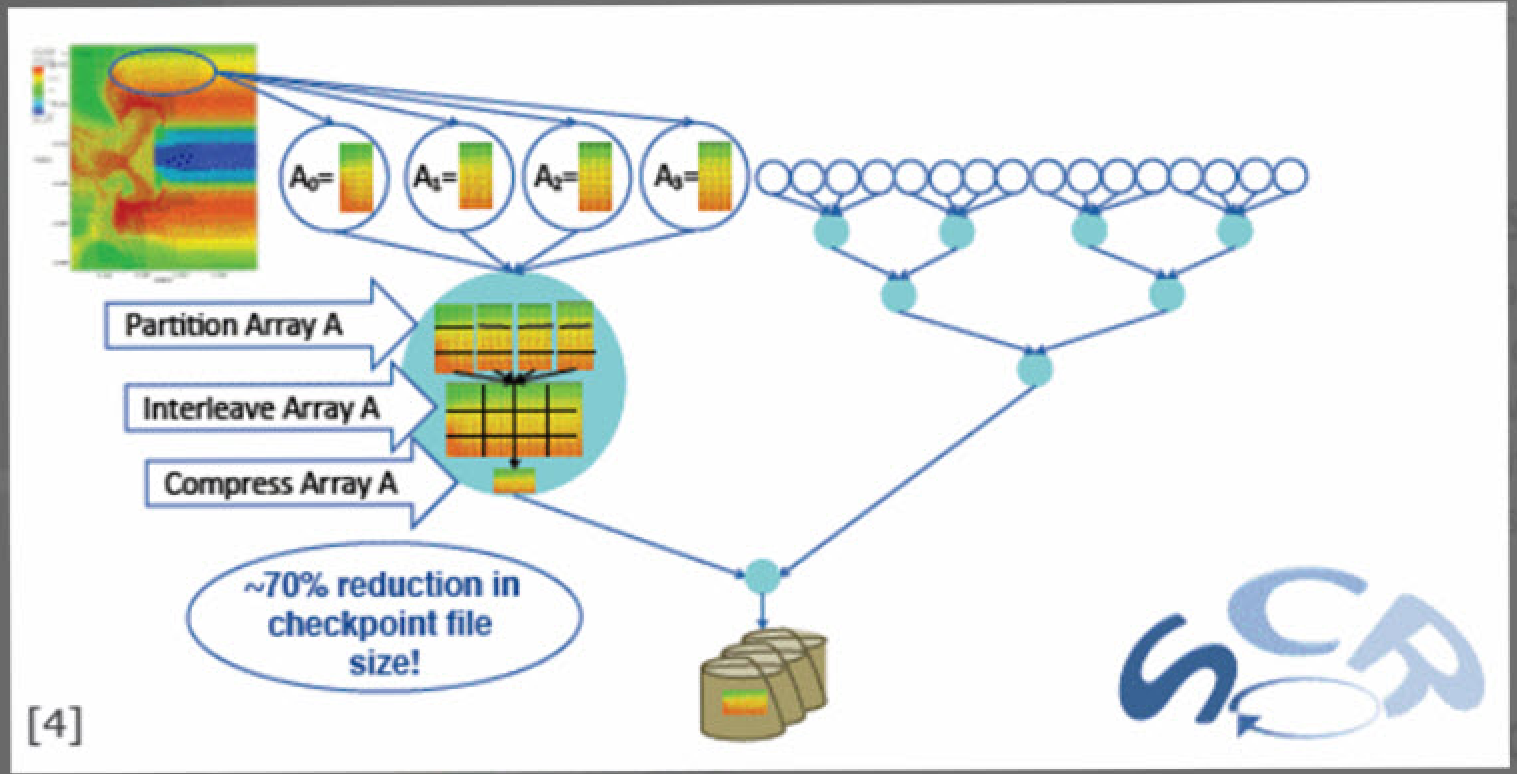

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...STRAINED COMPUTING

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...ALABLE RESILIENCE

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FUNDING AGENCY: DOE/NNSA, DOE/Office of Science, DoD, Lawrence Livermore National Laboratory (LLNL) LDRD

TEAM: Abhinav Bhatele, David Boehme, Peer-Timo Bremer, Greg Bronevetsky, Todd Gamblin, Tanzima Islam, Ignacio Laguna, Kathryn Mohror, Barry Rountree, Kento Sato, Martin Schulz, Tom Scogland (LLNL/CASC); Dong Ahn, Greg Lee, Matt LeGendre (LLNL/LC)

COLLABORATORS: Krell Institute, Kyushu Univ., LANL, LMU Munich, NC State Univ., Purdue Univ., RWTH Aachen, Tokyo Tech., TU Dresden, Univ. of Arizona, Univ. of California Davis, Univ. of Illinois at Urbana-Champaign, Univ. of New Mexico, Univ. of Tokyo, Univ. of Washington, Univ. of Wisconsin, Virginia Tech.

POSTER DESIGN: Abhinav Bhatele (LLNL/CASC, bhatele@llnl.gov)

IMAGE CREDITS: [1] Katherine E. Isaacs (LLNL/UCDavis), [2] Alfredo Gimenez (LLNL/UCDavis, [3] Barry Rountree (LLNL/CASC), [4] Kathryn Mohror (LLNL/CASC)

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

LLNL-POST-645229

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Scalability@LLNL's participation at SC15

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COMPUTATION

The Scalability Team @ LLNL

Supporting a Software Stack for Extreme Scale Systems

Making future extreme scale systems a reality requires not only significant efforts in architectures, programming models, and applications, but also substantial advances towards a highly scalable middleware infrastructure. The latter includes program development and code optimization tools and methodologies, support for fault tolerance as well as runtime mechanisms for power-efficient execution. We are a team of researchers in the Center for Applied Scientific Computing at Lawrence Livermore National Laboratory, working closely with researchers in the Development Environment Group at Livermore Computing, that focuses on the challenges in designing, implementing and maintaining elements of this software stack for both current high-end platforms as well as future extreme scale machines.

Research Areas

- Program Development and Analysis Tools
- Power-constrained Computing
- Scalable Resilience
- Interconnect Studies and Communication Optimizations
- Co-Design Tools and Methodologies

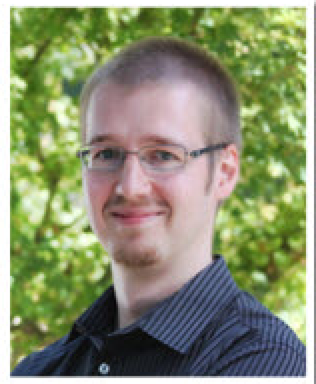
Software Repositories

Links to our software can be found at: github.com/scalability-llnl

Team

Research Staff


Abhinav Bhatele


David Boehme (PD)


Todd Gamblin


Tanzima Islam (PD)

News and Events

November 2015

SC15 Austin, TX | hpc transforms.

Scalability@LLNL's participation at SC15

Fall 2015
Community Involvement

First Workshop on Representative Applications (WRAp)
Tom Scogland and David Beckingsdale

MPI Forum Meeting, Fall 2015, Bordeaux, France
Martin Schulz

August 2015

Distributed Agent-Based Simulations and Practice (Chair Gennaro Cordasco)

Event-Action Mappings for Parallel Tools Infrastructures

May 2015

IPDPS 2015 Hyderabad, India

https://scalability.llnl.gov/

scala

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OpenSpeedS

RUCTURES
applications, tools and systems.
nes: SPINDLE.
virtualization: P^{N}MPI.
onents and launch simplification: Cram.

Cram

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Checkpoint millions of tasks using a 1 PB/s in-memory file system: CRUISE.
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Algorithm-based fault tolerance.

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Scalability@LLNL's participation at SC15

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CONFERENCE

Supercomputing 2015

WHEN
SUNDAY, NOVEMBER 15, 2015 TO FRIDAY, NOVEMBER 20, 2015

WHERE
AUSTIN, TEXAS, USA

Computation researchers will have a powerful presence at the 2015 International Conference for High Performance Computing, Networking, Storage and Analysis, which is returning to Austin for its 27th annual conference. SC15 draws an unparalleled ensemble of scientists, engineers, researchers, educators, programmers, system administrators, and developers for an exceptional program of technical papers, informative tutorials, timely research posters, and Birds-of-a-Feather sessions. The SC15 Exhibition Hall will feature exhibits of the latest and greatest technologies from industry, academia, and government research organizations.

Selected Livermore contributions to SC15:

TUTORIAL PRESENTATIONS

Insightful Automatic Performance Modeling
Alexandru Calotoiu, Torsten Hoefler, Martin Schulz, Felix Wolf

Power Aware High Performance Computing: Challenges and Opportunities for Application Developers
Martin Schulz, Dieter Kranzlmueller, Barry Rountree, David Lowenthal

How to Analyze the Performance of Parallel Codes 101
Martin Schulz, Jim Galarowicz, Don Maghrak, Mahesh Rajan, Matthew LeGendre, Jennifer Green

Practical Fault Tolerance on Today's HPC Systems
Kathryn Mohror, Nathan DeBardeleben, Eric Roman, Sanjay Kale

WORKSHOP ORGANIZATION

ESPT2015: Extreme-Scale Programming Tools
Andreas Knuepfer, Martin Schulz, Felix Wolf, Brian Wylie

HUST2015: Second International Workshop on HPC User Support Tools
Ralph Christopher Bording, Todd Gamblin, Vera Hansper

VPA2015: Second International Workshop on Visual Performance Analysis
Peer-Timo Bremer, Bernd Mohr, Valerio Pascucci, Martin Schulz